Twenty-second Annual Report

OF THE

North Dakota Agricultural Experiment Station

AGRICULTURAL COLLEGE
NORTH DAKOTA

TO

THE GOVERNOR OF NORTH DAKOTA

1912

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LETTER OF TRANSMITTAL.

Agricultural College, N. Dak., February 1, 1912.

Hon. John Burke, Governor of the State of North Dakota.

Sir: As required by Act of Congress, approved March 2nd, 1887, I hereby submit the Twenty-second Annual Report of the North Dakota Experiment Station for the year ending February 1st, 1912, together with a financial statement of receipts and disbursements, as required by law, for the government of fiscal year ending June 30th, 1911.

Respectfully,

CLARK W. KELLEY,

Pres. of the Board of Trustees, N. D. A. C.

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J. H. WORST, LL. D., Director.

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J. H. SHEPPERD, M. S. A., Vice-Director and Agriculturist.
W. B. RICHARDS, B. S. A., Asst. Agr. (Animal Husbandry).
R. C. DONEGHUE, M. S. A., Asst. Agr. (Soils and Plant Br.)
O. W. DYNES, B. S. A., Asst. Agriculturist (Poultry).
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G. L. MARTIN, B. S. A., Asst. Agriculturist (Dairying).
E. J. THOMPSON, B. S., Asst. Agr. (Animal Husbandry).

BIOLOGY.

H. L. BOLLEY, M. S., Botanist and Plant Pathologist.
W. B. BELL, Ph. D., Asst. Biologist (Economic Survey)
H. F. BERGMAN, B. S., Asst. Bot. (Mycology & Plant Sur.)
C. J. T. DORYLAND, M. S., Asst. Bot. (Soil Bacteriology).
O. A. STEVENS, B. S., Asst. Botanist (Seed Analysis).
D. G. MILBRATH, A. B., Asst. Bot. (Mycology & Histology).
J. R. CAMPBELL, B. S. A., Asst. Bot. (Seed Analysis).
W. H. MERCER, B. S. A., Asst. Botanist (Plant Breeding).
G. E. MILLER, A. M., Asst. Botanist (Economic Survey).

CHEMISTRY.

E. F. LADD, B. S., Chemist.
W. F. SUDRO, B. S., Assistant Chemist (Drugs).
R. E. REMINGTON, A. B., Assistant Chemist (Foods).
W. L. STOCKHAM, M. S., Assistant Chemist (Oils).
J. W. INCE, A. M., Assistant Chemist (Soils).
H. L. WHITE, M. A., Assistant Chemist (Cereals).
ADOLPH ZIEFLE, Ph. C., B. S., Assistant Chemist (Drugs).
E. B. PUTT, Ph. C., B. S., Assistant Chemist (Beverages).
L. A. CONGDON, B. S., Assistant Chemist (Foods).
LEVI THOMAS, M. S., Assistant Chemist (Baking).
M. L. DOLT, Ph. D., Assistant Chemist (Textile Fibers).
C. T. GUTHRIE, B. Pd., Ph. C., Assistant Chemist (Drugs).
J. H. WRIGHT, M. S., Assistant Chemist (Microscopy).
ADELE SHEPPERD, Assistant Chemist (Waters).
THOMAS SANDERSON, Miller.

HORTICULTURE AND FORESTRY.

C. B. WALDRON, B. S., Horticulturist and Forester.

VETERINARY.

LEUNIS VAN ES, M. D., V. S., Veterinarian.
E. D. HARRIS, D. V. M., Assistant Veterinarian.
A. F. SCHALK, D. V. M., Assistant Veterinarian.

C. V. KENNEDY, Farm Foreman.

SUB-STATIONS.

O. A. THOMPSON, B. S., Superintendent at Edgeley.
L. R. WALDRON, M. S., Superintendent at Dickinson.
E. G. SCHOLLANDER, B. S., Supereintendent at Williston.
E. D. STEWART, B. S., Superintendent at Langdon.
W. R. LANXON, Superintendent at Hettinger.

DEMONSTRATION FARMS.

W. R. PORTER, M. S. A., Superintendent.
E. W. HALL, B. S., Assistant Superintendent.

REPORT

To the Board of Trustees of the North Dakota Agricultural College and Experiment Station:

Gentlemen:

I have the honor to submit herewith the Twenty-second Annual Report of the North Dakota Government Experiment Station.

The following bulletins were published during the year:

No. 92. Paints: Their Service Condition.....E. F. Ladd and E. E. Ware

No. 93. Wheat Investigations, Milling, Baking, and Chemical Tests.....E. F. Ladd and C. H. Bailey

No. 94. Swamp Fever in Horses.....L. Van Es, E. D. Harris, and A. F. Schalk

No. 95. Alfalfa.

Part I. Practical Information for Alfalfa Growers.

Part II. Studies in Drought Resistance and Seed Production.....L. E. Waldron

PRESS BULLETINS

No. 43. Alfalfa.....L. R. Waldron, Dickinson Sub-Station

No. 44. Relation of the Corn Crop to Flax, Wheat and Other Cereal Cropping.....H. L. Bolley

No. 45. The Grasshopper Pest.....C. B. Waldron

No. 46 to 53. Flax Culture.....H. L. Bolley

During the past year, the work on the Experiment Station has not materially varied from that of preceding years. The same may be said of the sub-experiment stations. It has been the purpose of the station and sub-sta-

tions to continue investigations already under way, rather than to undertake the solution of many new problems.

I call your special attention to the reports of the Departments of Botany and Chemistry as indicative of the investigations in progress and of work being accomplished. The other Departments report in brief, inasmuch as their experiments are continuous and much of the data already secured has been published in bulletin form. The Department of Veterinary published a very exhaustive bulletin on swamp fever in horses (Bulletin No. 94). The investigations will be continued thru the coming year.

DAIRYING INDUSTRY.

For the third time, I wish to repeat my recommendation for a Dairy building. During the past year, unusual interest has been awakened in dairying. The importance of this industry was never more apparent. Many silos, as a consequence, have been constructed during the past season and a large number of dairy cattle have been purchased by farmers in different sections of the state .

The Agricultural College, however, is sadly in need of better equipment for giving instruction in this important industry. I can do no better than to repeat my recommendations of one and two years ago:

"The dairy interests of the state make it imperative that we erect a suitable plant for instruction and experimentation as soon as the finances of the state will warrant. Under present lack of facilities, instruction in butter-making is offered, during the winter months only, while all lines of experimental work is held in abeyance, pending the erection and equipment of a suitable dairy laboratory. A model dairy barn is also contemplated as well as a selected herd of dairy cattle.

"A fine field for experimental feeding for milk production is offered, as well as how best to care for dairy cows where the winters are long and severe. Different breeds of dairy cattle should be tested, both for profitable milk production and adaptation to local climatic conditions"

It is no longer a question of the state's ability to make provision for teaching dairying, but of the advisablity of longer neglecting this important industry. Money appro-

priated for agricultural education and experimentation is an investment which is returned to the state, many fold, while the ordinary appropriation, once spent, is gone forever.

MISCELLANEOUS WORK.

The division of College Extension has made good progress during the past year. Thousands of school children, as heretofore, engaged in corn and potato growing contests with great interest and great success. The samples of corn submitted by these children at the Grain Growers' Convention compared favorably with the best corn grown in the state.

The winners of the principal prizes were given a week's recreation and instruction at the Agricultural College which was greatly enjoyed by the young people. It is believed that these corn growing contests and the outing provided for the children at the Agricultural College, as here indicated, will exert a salutary influence on the young people of the state and better satisfy them with the conditions of rural life and rural occupations.

DEMONSTRATION FARMS.

The demonstration farms,—twenty-four in number, were well managed during the past year and gave satisfactory results. The number should be increased until at least one demonstration farm is located in every county and at least two in the larger counties.

SUB-EXPERIMENT STATIONS.

The sub-experiment stations have also had a successful year. The extremely droughty conditions that prevailed in 1910 exerted a detrimental influence upon the crops of 1911 but afforded, however, fine opportunity to demonstrate the advantages of moisture conservation and the results that may be realized where scientific methods of cultivation are adopted.

It is the aim of the Experiment Station to work along practical lines in all matters that effect crop production,

dairying, and animal husbandry, with a view to the best results without impairing the productivity of the soil. At the same time, much attention is being given to plant and animal diseases, with a view to their suppression or the lessening of their injurious influences.

The principles of moisture conservation and cultivation methods with that end in view are being given prominence. The eradication of weeds having perhaps the most direct bearing upon this question, will receive even larger attention in the future than in the past.

J. H. WORST,
Director.

AGRICULTURAL DEPARTMENT

To Director J. H. Worst,

Sir:

The work of the Agricultural Department has had only minor modifications during the past year. Some field plat trials to determine what fertilizing ingredients will be required for live stock and which for grain farming to maintain fertility have been established. This will necessarily be a long continued but very important trial.

Accounts with each field crop experiment enterprise have been kept so that its costs will be a matter of record for future calculations.

The correspondence during the past year has greatly increased. The number of letters written has increased about thirty per cent. These letters have been in reply to inquiries about how to handle crops and soil, how to prepare provender for live stock, how to feed them and to build suitable shelter for stock. The past two dry seasons have very greatly increased the call for information along these lines and the answering of such letters has, I believe, been of great service in helping our people get along during this stress period. The change in cropping methods and the introduction of live stock make much first hand and special information unusually valuable to them.

During the past year, from January to September, all of the Agronomy experiments were carried out by R. C. Doneghue as the position left vacant by the resignation of O. O. Churchill was not filled until September first, 1911.

O. W. Dynes was elected Associate Professor of Agronomy and assistant in Experimental Breeding in the Experiment Station. He has been placed in charge of the poultry and field crop trials of the Department.

The work outlined for this Department has been bent toward getting facts bearing on diversified cropping systems and the keeping of live stock on the farms of the state. A large amount of work has been introduced as a means of

studying economic plans for carrying pigs and other classes of live stock from the birth period until they are ready for market.

A change in the cropping systems of the state to include cultivated and forage crops has been the effort of this Department for nearly twenty years. These changes are now being made so rapidly by the general population of North Dakota farmers that details of management are most in need of study.

Our trials with corn have reasonably well established what can be done with that crop in the different parts of the state.

Clover growing and the regions where it is a safe crop has also been reasonably well worked out. The work in agriculture is so closely connected between the Central and Sub-Stations and Demonstration Farms that I find it necessary to discuss them together somewhat although I am separating their special discussions.

A leguminous crop for the dry regions now seems to focus on alfalfa and in consequence I am having large attention devoted to a study of it at all points where agricultural work is being put on. The Dickinson Sub-Station particularly has devoted a large proportion of its time to dry land trials with this forage plant.

The pedigree seeds produced by the Department are now being disseminated through the demonstration farms. This gives the opportunity of making a final and extensive trial with them at numerous points under the supervising eye of scientifically trained men at least one final season before they are distributed and enables them to be kept pure and of known pedigree so that all desirous of securing them can purchase the seed under the lead seal of the Station which serves as a guarantee to all purchasers that they are pure and what was sent out by the institution.

This method of field inspection of the pedigree seeds and of distributing them under the institution's seal has enabled me to list this year, certified seed grain as follows:

Blue stem wheat	2830 bushels
Fife wheat	100 "
Durum wheat	250 "
Winter rye	700 "
Oats	1450 "
Flax	300 "

This makes a total of 5,630 bushels of certified grain available to those who want a start in pure seed of known and tested strains .

The quantity of these seeds sent to the individual is limited, ranging from two bushels to one hundred bushels.

The season of 1911 brought a heavy scourge of rust to cereal grains at the Central Station farm and was so dry as to prevent the securing of catches of grass where average field cropping conditions were applied to the trials. Despite these handicaps, however, at least reasonably good results were recorded.

Following the studies on potato culture published in bulletin No. 90, special work in breeding potatoes by hill selection and pedigree records of individual strains has been instituted.

Experiments in:—(a) cost of production of milk under North Dakota conditions, (b) a study of types of cows and (c) feed requirements for different individuals are being carried out along the lines reported upon in bulletin No. 91.

A study in the cost of producing pork has also been instituted. This trial includes grazing pigs on different pasture plants hoging off grain and fattening on grain. It also includes a study in types and in early maturity. The results obtained from this trial are gratifying and encouraging to the industry in the state.

Cost of production trials and fattening experiments with sheep and lambs are also being carried on to show what can be done in the way of economic production and fattening of sheep.

The experiments in poultry are along lines similar to those reported heretofore. The individual hen records for egg production have exceeded those of any previous year.

Further trials with land drainage have been instituted

and observations made on the systems already installed.

The twenty-four demonstration farms and five sub-experiment stations have been carried forward on the same general lines as heretofore. With the exception of the Hettinger Sub-Station little change has been made from the plans outlined a year ago. As I have made monthly informal reports to you on each of the sub-stations and am filing with you formal annual reports for each of them and for the demonstration farms I will include little detail concerning them here.

The failure of record of the Hettinger Sub-Station bill by the last legislature has left us without maintenance funds for that work. The farm is largely broken up and has considerable equipment in horses, cows and poultry in addition to implements, buildings and machinery on hand which must be carried along or suffer serious deterioration and loss. As the U. S. Government has made a considerable investment in the time of an expert and in apparatus at the Hettinger farm and as the results they are interested in come from the recorded history of those plots we are under special obligation to carry on those trials without interruption.

I have ordered the expenses there curtailed as much as possible without making too serious inroads on the work, according to instructions received from yourself also from the Board of Trustees on Nov. 14, 1911.

The Sub-Stations have been given largely specific problems to work out and demonstrations with special cropping plans suitable for their districts.

It has not been deemed advisable to undertake trials aside from those with crops and cropping systems including trees, fruit and garden vegetables. The successful plans for growing these crops must be worked out in their respective regions .

Experiments in the feeding and growing of live stock to be effective require men especially trained for that work while our men on those farms are especially trained in lines of Agronomy. To carry on live stock trials of much value a considerable number of animals are required which would make larger land areas than the Sub-Stations possess neces-

sary and much more of building equipment for live stock than they are now supplied imperative.

These agronomists are determining what grasses, grains and forage crops are successful in those districts and what cropping systems are advisable but feeding trials with these grains and forage crops can be better and more economically made by shipping them to the Central Station than by carrying them out on the Sub-Stations. It has been my policy to carry out nothing on the Sub-Stations which can be done as well on the Central Station as trials can be more economically carried out here.

At Williston heavy stress is laid on methods of irrigating crops and a study of the successful crops and systems of cropping for irrigation projects.

At Dickinson Sub-Station the heaviest line of work has been to determine the most successful alfalfa strains and the best methods of culture for that crop.

At Edgeley a strong study has been made with rotations or cropping systems, drouth resisting cereals and on brome grass and alfalfa as pasture and forage crops.

The Langdon Sub-Station's work has been outlined largely as a demonstration of the system of farming advisable for that region with limited studies of rotation methods and crop varieties.

At the Hettinger Sub-Station it is proposed to put heavy stress on horticulture and upon demonstrating the better methods of carrying out cropping systems for the region.

Our Sub-Station superintendents have been encouraged in giving information and assistance to their neighbors on planting farm groves, tree plantations, testing seeds, planning cropping systems, etc., and by attending institute meetings, agricultural clubs and through farm-to-farm visits.

The work of the demonstration farms consists in applying and hence disseminating the methods worked out by the station and sub-stations and of attending to the distribution and tracing of the pedigree grains and seeds sent out. The results obtained are set forth in detail in the special report covering that work which I am submitting to you.

Some changes have been made in the cropping plans adopted on the different demonstration farms. This has

been done to make them conform to the latest information worked out by the Central and Sub-Station farms also with facts recorded on the demonstration farms.

The detail of the specific lines of investigation and demonstration have been under the direct charge of those who are associated with me in prosecuting the work

The results secured are largely attributable to their efforts in recording the data and observing the phenomena. They are accredited in the published record with their part in this work. My thanks are hereby tendered to them for their efficient service.

Respectfully submitted,

J. H. SHEPPERD,

Agriculturist and Vice Director.

CHEMICAL DEPARTMENT

To J. H. Worst, Director:

Sir:

I herewith present my Twenty-second Annual Report as Chemist for the Experiment Station for the calendar year of 1911. The work has been carried along the same general lines as in preceding years, although, for the past two years seriously handicapped owing to lack of proper laboratory facilities until the new building was ready for occupancy in July.

The work of the Department has covered a wide range of subjects not only in research lines, but also in connection with the enforcement of the laws which it is made the duty of this Department to supervise. The work is, therefore, divided into fourteen principal divisons in order to facilitate a more economical use of time and facilities. While a sharp line cannot be drawn between the several divisions of work, each division has its own definite line, though at times it is necessary for one division to give assistance in the work of another division. The principal lines of work in the several divisions during the past year may be briefly summarized as follows:

Division of Agricultural Chemistry—J. W. Ince, Chief of Division. During the year particular attention has been paid to the conducting of fertilzer experiments both on the Station grounds and in co-operation with farmers of the state. Analyses of soils, including tests made upon soils from several demonstration farms and branch stations, has been an important feature. A study of plant nutrition has also been carried on. Analyses of stock foods paris greens, fertlizers, sugar beets and other products submitted by the people of the state have taken considerable time.

Division of Industrial Chemistry—L. W. Sargent, Chief of Division. In this Division, as heretofore, the main line of work has been in paint investigations, and has included the

analyses of a large number of paints, oils, turpentines, varnishes, the examination of fuels, building materials, clay and a continuation of the experiments made in the practical testing of paints, and paint products. There has been added to this Division during the year a complete outfit for the grinding, mixing and manufacture of paints, in order that we may carry on the work wholly under our own control. It might be added that this work has been supported by the Paint Manufacturers' Association of the United States also by the National Lead Company. During the year two bulletins have been published; one, giving the composition of a number of paints and white leads as found upon the market; and Bulletin No. 92 dealing with paints and their service condition, illustrated to show the effects of various combinations of paint pigments and vehicles, and their effect upon the wearing quality of the paint, as well as experiments illustrating the influence of different types of lumber.

Division of Food Chemistry—Roe E. Remington, Chief of Division. While the work in this division has been mainly in connection with the enforcement of the Food Law of the State, there have been carried on a number of lines of research work, including the examination of vinegars, mince meats, rice and bread. Examinations have also been made of many samples of products submitted by manufacturers, by general dealers and the consuming public.

Division of Physiological Chemistry—H. L. White, Chief of Division. The work of this Division has been a continuation of that of preceding years; a study of the acidity of flours; a study of the gluten and its relation to the expansive properties in flour and bread-making; a study of the acid properties of gluten and ash content; the storing of flour with relation to its bread-producing quality; and the storing of wheat to determine the effect upon its milling quality. Examinations have been made of a large number of products, including the analyses of urines and the examination of products to determine the presence of poisons.

Division of Water Analysis—Adele Shepperd, Chief of Division. In this Division attention has been given largely to the analysis of waters as submitted by the people of the

state. At first this may seem of interest only to the individual submitting the sample, but when we consider the great variety of waters that are found in the wells of this state, even in the same locality, and the effect that may be produced upon the health of the individual, or on the animal, or its value for use in boilers, or for sprinkling lawns, one can readily understand that it becomes an important feature of our work. During the past year there have been analyzed 362 samples of water.

Division of Pharmacy—Adolph Ziefle, Chief of Division. The work in this Division has been confined largely to the examination of drugs and pharmacopoeial preparations as taken up at the drugstores throughout the state with particular reference to determining whether these products conform with the requirements of the U. S. Pharmacopoeia, or whether or not they conform with the claims made upon the labels under which they are dispensed. Analyses have also been made of a large number of samples submitted by physicians, druggists and others.

Division of Materia Medica—E. B. Putt, Chief of Division. The work in this Division has been largely confined to an examination of patent medicines and proprietary products, including a special investigation now under way with the various head-ache preparations upon the market, also, with the so-called kidney cures. Special investigations were made of the toxic properties of mescal, largely used as an intoxicating beverage by Indians especially in the southwestern part of the country.

Division of Beverages—W. F. Sudro Chief of Division. The work of this Division has had to do largely with an examination of all classes of soft drinks, pops, sodas, ciders, etc., to ascertain if the same are pure, or if they contain preservatives, coal tar dyes, saccharin or added deleterious ingredients. Examination has also been made of a large number of wines, beers and alcoholic liquors as found on sale at drug stores.

Division of Milling Experiments T. Sanderson, Miller. As in previous years the work has been largely a continuation of cooperative experiments with the U. S. Department

of Agriculture. This has given us opportunity to make milling tests with wheats from all parts of the country, and of all classes and varieties. Much of the data for 1910 and the early part of 1911 is given in Bulletin No. 93 which deals with wheat investigations, milling, baking and chemical tests, and specifically with questions in connection with a study of the crude protein content of hard spring and durum wheats raised on the farm during several successive years; the relation between crude protein in wheat and the by-products or feed products in milling; loss in milling; and the cause of variations in the loss of milling. There have also been published several articles in special bulletins issued by the Department during the year. The problems under special investigation last year have been continued during the present year, and include methods of tempering wheat for storing; testing of bin-burned wheat, immature wheat, wheat threshed from the shock as compared with wheats threshed from the stack; and a further study of the wheats and their milling properties as grown upon the different demonstration farms.

Division of Baking and Testing—Levi Thomas, Chief of Division. Since Mr. Bailey resigned to accept a similar position in Minnesota, Mr. Thomas has had exclusive charge of the baking tests with the various flours as milled for the experiments outlined above and with the assistance of Mr. Stockham has made a study of the water content of wheat for milling tests. Much of the data as published will be found in Bulletin No. 93 and in the special bulletins.

Division of Illuminating Oils and Gasolines—W. L. Stockham, Chief of Division. The State Law makes it the duty of this Department to make examinations and tests of oils and gasolines as submitted from time to time by the State Inspector of Oils. During the year a large number of tests have been made, including the determination of the gravity, fire test, flash test, distillation test, and a determination of the sulfur or other ingredients present in illuminating oils.

Division of Inspection—L. A. Congdon Chief Inspector of Foods. C. P. Guthrie, Chief Inspector of Drugs. When

we consider the necessity of visiting all parts of the state for the purpose of taking up samples of food products to ascertain their purity, keeping in touch with the sanitary conditions throughout the state to see that all the meat-markets slaughterhouses and other places are kept in proper condition so that all articles of food shall be in good condition as supplied to the public; looking after the sale of commercial fertilizers, formaldehyde, paris green and feeding stuffs to see that the same are as represented and registered for sale under the laws of the state; this becomes an important field of work.

During the year there have been printed and published by the Department bulletins Nos. 92 and 93, already referred, and Paint Bulletin No. 5. A number of special circulars have been issued during the year dealing with inspection work, and special bulletins as follows:

Special Bulletin No. 29: Model Food Law; Examination of Meats Supplied to Fargo from Minnesota with particular reference to the inspection of the Hanson herd near Moorhead.

Special Bulletin No. 30: List of Beverages registered for 1911; registrations cancelled; Sal Vet; analyses of tomatoes and food products.

Special Bulletin No. 31: Meat Inspection and disease; an address on Meat Inspection by Dr. Van Es; analyses of foods; Velvet Chaff wheat; and registrations.

Special Bulletin No. 32: North Dakota Lard Law; Net Weight Law and Bread Law; Munyon's Kidney Cure a fraud; analyses of foods; Why Food Interests Want Uniformity by J. Q. Emery; late registrations.

Special Bulletin No. 33: Exposure of Dr. Bertha C. Day; and her methods; patent medicines including Parnotis, Hanford's Balsam of Myrrh, headache preparations, and Make-Man-Tablets; analyses of canned tomatoes; analyses of waters.

Special Bulletin No. 34: Analyses of Proprietary Products including Himalya and McLean's Tar Wine Lung Bal-

sam; analyses of foods; analyses of brandies; late registrations.

Special Bulletin No. 35: A discussion of the Snuff Law; polished rice; warning to dealers in dairy products including ice cream; several patent medicines; notice with regard to rotten eggs being illegal in North Dakota; analyses of spirits of peppermint; score of bakeries, slaughterhouses, meatmarkets and grocery stores throughout the state.

Special Bulletin No. 36: Short-weight Lard; analyses of food products; analyses of ice cream; analyses of essence of peppermint; tempering of durum wheat; winter wheat vs. spring wheat; a number of patent medicines.

Special Bulletin No. 37: Analyses of tincture of iodine; analyses of food products; hair tonics found to contain wood alcohol; dairy scores for Feeco; analyses of a number of patent medicines including Epi-o-tone, Dr Gunn's Pain Expeller, May-a-tone, Boschee's German Syrup, etc.

Special Bulletin No. 38: Moisture content of wheat; milling of emmer for bread-making; food products analyzed; score for confectionery stores, analyses of a number of patent medicines.

Special Bulletin No. 39: Notice with regard to decomposed and filthy cream; warning to bottlers; analyses of food products; sugar beets and soft drinks.

The results of analyses for most of the products examined have been given either in the Annual Report Part II or in the regular or special bulletins.

The details of the special lines of investigation have been under the direct charge of my assistants, and to them is due credit for a large amount of the success that has been attained in this work.

Respectfully submitted,

E. F. LADD,
Chemist.

THE DEPARTMENT OF BOTANY AND PLANT PATHOLOGY

Director J. H. Worst:

Sir: The work of the Department of Botany and Plant Pathology of the Experiment Station for the year 1911 is a continuation and extension of the work of previous years. No new lines of work have been laid out other than have naturally followed from the development of the plans of the department as previously outlined. I shall not at this time undertake to detail the results in all of the lines of investigation, but rather point out some of the results obtained and a few features as to the methods of work.

Soil Studies: Since the year 1900, when I first had reason to suspect that the cereal producing soils of the northwest were disease infected rather than chemically depleted and that the marked deterioration in crops of flax, wheat and other cereals is more properly ascribed to the results of soil and seed infection, poor sanitary conditions of the soil and of the seed than to lost fertility, I have laid out a wide range of experiments to ascertain the biological relation of our cereal crops to the soil and to the various methods of cropping.

Each assistant in the department has been given a specific problem to work upon, and all of the different lines of work have been coordinated in such manner that results in one section of the work may be closely correlated to those which may be obtained in another. Personally I have kept up a wide range of special trial experiments over the entire field and have worked directly with each of the separate workers upon the particular topics, specimens and experiments with which they have been engaged, with the result, I believe, that this department has established beyond any possible question the correctness of the position as outlined in the foregoing statement.

Further than this we have examined the seeds of cere-

als from the chief cereal and flax producing regions of the world and find that the diseases which we find destructive here are world wide in their distribution, cosmopolitan with each particular crop.

The essential feature is that we have proved conclusively that many fungi which were supposed to be only accidental saprophytes on decaying straw are really virulent parasites upon the growing crop for which they are specific, and, strange to say, though usually not so considered, most of these are internal parasites transmitted internally in the seed. Quite commonly the embryo plant is attacked when it is first formed in the seed on the mother plant. Such a seed is amenable to treatment for prevention with great difficulty, and under ordinary conditions transmits the disease to new soil areas with absolute certainty. Essentially most of the diseases remain persistently in the soil for a number of years.

The above statement with the proofs that we have now accumulated, I believe, **form an argument for crop rotation and proper arrangement of crops in a natural series which is stronger and clearer than any that has heretofore been given. It gives a clear understanding of a feature which has been well known to biologists for a number of years, that climatic conditions are generally of more importance in cropping than soil characters, and that varietal characters are also of more importance than soil characters.**

When I make this statement I would not minimize the value of soil fertility, but would have it understood that it is my belief that so far as wheat, flax, oats, barley and many other small grains are concerned, if cropping is not done in such manner as to eliminate the seed and root diseases which are characteristic of these crops, it will make little difference, one year with another, how fertile the land is. Indeed, a soil poor in nitrogenous matter is as liable to give plump grain under such conditions as one particularly rich in it; and one which has an abundance of mineral matters in proportion to the organic matters is more liable, under such conditions, to give plump grain than the more fertle soil of organic type. In other words, while no one can doubt but that it is essential to have certain types of soil fertility possessing the general plant foods in reasonable proportion,

nevertheless tillage, sanitation and climatic conditions are the primary factors in the actual production of the crop.

When these are properly considered one may use natural and artificial fertilizers to enrich his land to the fullest extent desirable, but if these matters of sanitation are not properly controlled the use of certain types of fertilizers is essentially contra indicated. Thus, for example, with the soil already infected with the root diseases of wheat, flax or potatoes, it is undesirable to use ordinary barnyard manures when those crops are to be grown, unless provision has been made by proper rotation or other method to eliminate such diseases. The result must inevitably be shrivelled seed under normal cropping conditions as to weather.

In other words the conclusions that we have reached from our experiments in all lines may be tersely stated as follows: **The deterioration of flax and cereal grains in the soils of the Red River Valley and of the northwest are not primarily due to lost fertility.** Constant cropping, under careless methods of handling seed and soil, has introduced into the soil and developed in the general seed supply a set of parasitic diseases, which, under normal weather conditions and soil conditions, very largely destroy the crop.

Lands which are virgin and free from the diseases, lands such as well worked corn ground and other cultivated lands under proper long seried rotations give their increased yields over old lands **not because they are more fertile, not because of the chemical elements they contain, but because their physical texture and sanitary condition is better.** Such lands are rapidly brought to the condition of the older lands which have been long under cultivation thru the introduction of various parasites which are carried either on the seed or in the seed, or in great quantities in uncomposted manure made from straw produced upon deceased fields.

What To Do: The road to an improved condition is evident. **Crop rotation properly arranged with reference to the crops which bear certain diseases; Seed selection** with reference to procuring seed either of disease resistant type or from parent crops which were comparatively undiseased; **Seed grading** to weight, quality and normal color because such are less apt

to be internally diseased and seed disinfection of efficient sort must be adhered to.

The features which we have outlined in the preceding paragraphs will perhaps explain to many why crop rotations and cultivation methods from which they had expected much, failed them when they had least expected. It may explain to some why their new lands failed to give them plump wheat and other grains as such new lands once did. It may give to a great many a new hope for better agriculture to whom the doctrine of lost fertility was only a doctrine of disparagement. When I say this, I would not have anyone draw the conclusion that I believe soils cannot be injured with regard to their chemical content. I only believe that the doctrine of lost fertility has been overworked to explain too many things.

I do believe that it will be possible to use all of the available natural and commercial fertilizers to advantage, but that in doing so we must use them with intelligence and with special regard to those other matters of seed and soil sanitation. It has been hard for many to understand the philosophy of crop rotation; with those persistent failures coming at the most unexpected times, and as such diseases are infectious and carried by wind, water and farming implements, and the various carriers of commerce, it will be clearly seen that to get legitimate results people generally must be educated to be concerned in such matters as soil and seed sanitation. The single farmer can get results which will pay him for his most careful work whether his neighbors do or do not pay attention to what he does, but if all the farmers of the neighborhood and of a large wheat or cereal growing district understand this matter of soil and seed sanitation and properly associate it with soil fertilization, then each individual's work will count far more than it otherwise could have been done.

I herewith embody the essential parts of the report of Mr. T. D. Beckwith assistant bacteriologist and plant pathologist upon the fungus and bacterial survey made during the years 1910-'11 in continuation of similar work of this department in previous years. A large part of this work has a direct bearing upon the proper philosophy of the work of wheat cropping.

In speaking of cereal root-blight fungi this department still adheres to the use of the generic names only. Our inoculation and infection experiments are carried on by pure cultures of specific organisms but it is evident that no one has yet done sufficient work to justify them in the naming of the species of the root diseases in cereals.

Survey of Wheat Diseases Producing Fungi, Found in the Soil and on or in Various Portions of Living Wheat Plants by T. D. Beckwith: "In accordance with plans laid out by you during the fall of 1909, the work of continuing a survey of wheat diseases found in the soil and on various portions of the wheat plant notably the culms, have been continued. We have used the same method in this survey during the past year which was put in practice during the year 1909-1910. This method has been as follows:

Test tubes for culture work have been prepared by placing in the bottom of the tube a small piece of absorbent cotton, filling the tube approximately a half inch. This cotton has been thoroly moistened with distilled water. The tubes were then plugged and autoclaved, giving thus a sterile moist medium for the germination of fungi. In the first step of the work a double series of tubes, made according to this method, was prepared. The first series of 200 was composed of sections including the first aerial internodes of 200 wheat plants, and the second 200 was made to include the succeeding nodes from the same plants. These plants were selected at random from the twenty wheat fertilizer plots on the biological portion of the experiment station farm, and were so selected that ten plants were taken from each plot. It was deemed advisable to use both internodes and nodes because previous experiment had shown with the flora of fungi that the forms in the internodes differed from the forms found in the nodes very materially. These sections were prepared by cutting with sterile scissors portions from the culms of the plants. These portions were then sterilized for approximately one minute in a one per cent Formaldehyde solution. This solution is not one per cent by weight, but was made by adding one c.c. of forty per cent commercial grade to one hundred c. c. of water. After this sterilization, the sections were removed with sterile forceps and washed thoroughly in sterile distilled water in order to

wash off the formaldehyde, which otherwise might prevent germination. These culture tubes thus prepared were then incubated at an incubator temperature of 29°C for seven days. Microscopic examination was then made. The following tables show the results of this examination for the year 1911.

Table, Showing Infection of Internodes 1910.

Plot No.	Colletotrichum Sp.	Fusarium Sp.	Macrosporium Sp.	Helminthosporium Sp.
1	20	0	30	0
2	30	0	60	10
3	0	0	70	20
4	10	0	60	10
5	20	0	60	30
6	0	0	40	10
7	0	0	60	10
8	10	10	50	10
9	20	0	50	50
10	10	0	20	70
11	0	0	10	20
12	20	0	50	10
13	10	0	0	20
14	10	0	10	10
15	0	0	0	0
16	0	0	20	10
17	0	0	50	30
18	10	0	20	20
19	0	0	40	50
20	0	0	20	10

Table Showing Infection of Nodes 1910.

Plot No.	Colletotrichum Sp.	Fusarium Sp.	Macrosporium Sp.	Helminthosporium Sp.
1	10	0	80	0
2	10	0	70	10
3	0	0	60	30
4	20	0	50	30
5	20	0	20	50
6	0	0	30	0
7	0	0	50	30

8	0	0	30	0
9	20	0	30	50
10	10	0	30	60
11	20	0	20	20
12	0	0	70	30
13	30	0	0	30
14	40	0	10	20
15	0	0	0	10
16	0	0	20	10
17	0	0	80	40
18	20	0	10	20
19	0	0	50	40
20	0	0	30	10

It will be noticed upon examination that the per cents of infection from those various pathogenic fungi differ very materially from the results obtained from the crop of 1909-1910. It has been learned that aproximately four times the amount of moisture fell during the growing season of 1909 than during the like period of 1910. In one case the season was fairly moist, but during last year our conditions were semi-arid. Doubtless then certain physiological factors are to be considered. We are not able to determine the proportionate value of the different factors of light, heat, moisture, food supply, etc., but the comparison of the per cents of infection of the two seasons for like portions of plants, shows that there was a much greater infection during the season of 1909, due to the same four pathogenic fungi noted during the period of 1910. For this purpose of comparison, parallel tables are here appended for the period of 1909.

Table, Showing Infection of Internodes—1909.

Plot No.	Colletotrichum Sp.	Fusarium Sp.	Macrosporium Sp.	Helminthosporium Sp.
1	50	20	20	50
2	40	40	20	20
3	10	0	30	20
4	30	30	80	50
5	36	30	60	20
6	90	40	30	70

7	30	60	20	50
8	20	20	30	0
9	30	30	70	30
10	20	0	20	20
11	60	30	20	20
12	70	10	50	0
13	50	20	50	70
14	90	60	20	100
15	50	10	10	40
16	70	40	20	30
17	80	10	20	40
18	80	40	20	40
19	60	40	40	20
20	90	30	30	0

(For further data see Twentieth Annual Report, pages 38 to 47 inclusive.)

Table, Showing Infection of Nodes—1909.

Plot No.	Colletotrichum Sp.	Fusarium Sp.	Macrosporium Sp	Helminthosporium Sp
1	100	70	60	70
2	50	70	60	50
3	30	0	10	10
4	40	30	90	20
5	30	50	80	20
6	90	60	50	80
7	30	20	20	50
8	20	40	70	10
9	30	10	60	50
10	20	10	40	50
11	90	30	30	30
12	50	20	50	10
13	50	40	70	70
14	90	60	60	100
15	60	0	40	20
16	60	20	60	20
17	90	10	20	60
18	70	50	40	30
19	100	20	70	30
20	40	30	60	30

In order to show at a glance what this comparison amounts to, the following table is presented:—

Internodes:	1909.	1910.
Colletotrichum sp.,	52.5	8.5
Fusarium sp.,	27.5	0.5
Macrosporium sp.,	53.0	36.0
Helminthosporium sp.,	34.5	20.0

Nodes:	1909.	1910.
Colletotrichum sp.,	57.0	10.0
Fusarium sp.,	33.5	0.0
Macrosporium sp.,	53.5	37.0
Helminthosporium sp.,	40.5	24.5

The comparisons shown here are figured from the total number of internodes and nodes examined for that year."

Soil Survey Work 1910-1911 by T. D. Beckwith: "According to your plans previously laid out, in order to learn, if possible, something concerning the bacterial flora of different type from that found on the Agricultural College farm, examinations were made, using soils from certain other localities in the state. The soil selected first was such as is found at Rugby, North Dakota, and the samples were taken from the demonstration farm (Lavik farm) near that place. (For details of the crop rotation see report of superintendent of demonstration farms, W. R. Porter.) The demonstration plots are five in number and have been undergoing a five year rotation, each plot, therefore, having a separate and different crop. Samples were taken from each of these demonstration plots at the depth of two and seven inches. The sample at seven inches was taken about an inch below the cut of the furrow, in order to get the undisturbed soil, if possible. Following are the results showing bacterial counts in these plots from soil samples taken in Sept., 1910: (For comparison see Table 5, page 46 of the Twentieth Annual Report.)

On Beef Agar:

Plot No.	2 inches	7 inches
1	1,833,200	833,300
2	1,333,200	399,900

3	1,810,900	633,300
4	2,044,200	844,400
5	2,177,600	1,666,500

On Mannite Agar:

Plot No.	2 inches	7 inches
1	2,077,600	2 244,200
2	1,344,300	811,000
3	3,844,300	1,255,400
4	2,921,900	1,588,700
5	3,633,000	1,466,500

The following fungi were found to be present in these samples at this time. These fungi are ones which appeared upon the soil count plots:

Plot 1: 2 inches, Fusarium and Macrosporium
7 inches, Alternaria

Plot 2: Nothing.

Plot 3: 2 inches, Fusarium and Colletotrichum.
7 inches, Colletotrichum.

Plot 4: 7 inches, Macrosporium.

Plot 5: Nothing.

Second Sampling, Rugby, North Dakota, March 25, 1911: In this survey, soils were taken merely two inches below the surface as the frost was still in the soil and with the appliances at hand it seemed next to impossible to get accurate samples lower than this. Instead, however, two samples were taken from each plot—one from the North and one from the South side of the plot. Each sample was taken at a point midway between the center of the plot and its edge. The following results show the counts from these samples of soil at this time:

Plot 1:	North—On Beef Agar	2,444,200
1:	South—On Beef Agar	4,910,600
1:	North—On Mannite Agar	9,999,000
1:	South—On Mannite Agar	15,076,300

Plot 2:	North—On Beef Agar	2,722,000
2:	South—On Beef Agar	555,500
2:	North—On Mannite Agar	6,777,100
2:	South—On Mannite Agar	5,755,000
Plot 3:	North—On Beef Agar	3,188,600
3:	South—On Beef Agar	1,622,100
3:	North—On Mannite Agar	8,854,700
3:	South—On Mannite Agar	9,821,200
Plot 4:	North—On Beef Agar	1,088,800
4:	South—On Beef Agar	1,055,500
4:	North—On Mannite Agar	6,066,100
4:	South—On Mannite Agar	6,121,600
Plot 5:	North—On Beef Agar	3,377,400
5:	South—On Beef Agar	1,922,000
5:	North—On Mannite Agar	5,910,500
5:	South—On Mannite Agar	6,232,700

On averaging these results we find the following, which may be taken as representative of the bacteriological condition of the soil at that date:—

March 25, 1911.

Plot 1:	On Beef Agar	3,677,400
1:	On Mannite Agar	12,537,800
Plot 2:	On Beef Agar	1,638,800
2:	On Mannite Agar	6,266,100
Plot 3:	On Beef Agar	2,405,400
3:	On Mannite Agar	9,338,000
Plot 4:	On Beef Agar	1,072,200
4:	On Mannite Agar	6,093,900
Plot 5:	On Beef Agar	2,649,700
5:	On Mannite Agar	6,071,600

The following fungi were found present in these plots at this time:

Plot No. 1. North side: Colletotrichum, Alternaria.
South side: Colletotrichum.

Plot No. 2. Nothing.

Plot No. 3. North side: Colletotrichum, Helminthosporium.
South side: Colletotrichum.

Plot No. 4. North side: Macrosporium, Alternaria.
South side: Alternaria.

Plot No. 5. North and South sides: Colletotrichum.

In co-operation with the State Geological Survey, the following samples of soil have been examined, taken from Barnes County, North Dakota, and collected by Messrs. Anderson and Rommel of the Survey, and were taken by means of a soil augur:

July 15, 1911—Marshall silt loam.

Sec. 12, Twp. 141, Range 58. This was an old wheat soil.

Sample 1 was taken four inches below the surface.
Sample 2 was taken 1 foot below the surface.
Sample 3 was taken three feet below the surface.

Counts were made upon both beef and mannite agar. Following are the results:

	On Beef Agar.	On Mannite Agar.
Sample 1, 4 inches,	2,444,200	2,577,520
2, 1 foot,	1,444,300	2,099,790
3, 3 feet	822,140	2,166,450

Sec. 4, Twp. 141, Range 57. Virgin soil.
Sample 4 was taken four inches below surface.
Sample 5 was taken one foot below surface.
Sample 6 was taken three feet below surface.

Following are the results of bacterial counts:

	On Beef Agar.	On Mannite Agar.
Sample 4, 4 inches,	2,410,870	4,888,400
5, 1 foot,	1,299,870	2,022,020
6, 3 feet,	566,610	888,800

The following are the fungi which appeared upon these plates:

Sample 1: Nothing,
2: Fusarium-Alternaria.
3: Fusarium,
4: Nothing,
5: Alternaria,
6: Alternaria-Macrosporium.

The change in count in the above according to the depth is very interesting and shows conclusively that the very fine texture of the soil causes a rapid lowering of the number of bacteria a short distance below the surface. Also the presence of the Fusarium fungus in the old wheat soil at a depth of one foot and three feet as demonstrated in Samples No.2 and 3 is of especial interest. It is possible that it may show certain anaerobic functions of this fungus, though possibly it may only mean that such fungi are deeper by being attached to diseased roots possessing air cells.

August 1, 1911, N. E. ¼ Sec. 28-Weimer Twp, Barnes County. Virgin soil.

	On Beef Agar.	On Mannite Agar.
Sample 1, 2 inches	1,866,480	5,143,930
2, 1 foot	822,140	1,610,950
3, 3 feet	499,950	1,466,520

S. W. ¼ Sec. 33, Weimer Twp., Barnes County. Old wheat soil.

Following are the results:

	On Beef Agar.	On Mannite Agar.
Sample 4, 4 inches	2,555,300	5,688,320
5, 1 foot	1,677,600	3,666,300
6, 3 feet	411,070	844,360

N. W. ¼ Sec. 28, Twp. 142, Range 56, Barnes County.

Following are results:

	On Beef Agar.	On Mannite Agar.
Sample 7, 4 inches	2,055,350	3,388,550
8, 1 foot	844,360	1,977,580
9, 3 feet	799,920	1,710,940

It is not stipulated whether this was taken from virgin soil or old wheat soil.

N. E. ¼ Sec. 17, Twp. 142, Range 56, Barnes County.

Following are the counts:

	On Beef Agar.	On Mannite Agar.
Sample 10, 4 inches	1,177,660	3,277,450
11, 1 foot	688,820	1,055,450

The following fungi were demonstrated in the above samples:

In No. 1: 4 inches, Macrosporium and Alternaria.
1 foot and 3 feet. Nothing.

2: 4 inches, Colletotrichum.
1 foot, Fusarium
3 feet Nothing

3: 4 inches, Nothing

4: 4 inches, Macrosporium
1 foot and 3 feet, Alternaria
1 foot, Alternaria.

Survey of Wheat, Grains in Plots 1 to 20—Crop of 1910 by T. D. Beckwith: The general survey of wheat culms having shown seasonal differences and unexplained conditions in mycological flora, we have endeavored to learn what fungi were to be found infecting the various portions of the seed of wheat taken when approximately mature from plots 1 to 20. The work was divided into a number of various subdivisions:

First an attempt was made to find out what generic forms are present on the seed coat of the wheat grains, regardless of their pathological significance. The method was as follows:

Twenty-five seeds, selected at random from the plants of the crop of each plot, were washed in 10 cc. of sterile distilled water. These seeds were thoroly rinsed and shaken in this tube of water in order that any fungus spores present on the seed coats might be washed off and held temoprarily in suspension. From this washing three tubes of mannite agar were inoculated each with one cc. of this wash water. Plates were poured and incubated fourteen days at twenty-eight to thirty degrees Centigrade. The following results show the number of colonies of fugus to each twenty-five seeds by the method described above:

Plot No.	Colletotrichum sp.	Alternaria sp.	Aspergillus sp.	Penicillium sp.	Cephalotherium sp.	Helminthosporium sp.
1	0	33	4	14	0	0
2	60	0	5	14	0	0
3	25	14	8	47	0	0
4	11	8	5	88	0	0
5	8	0	0	40	0	0
6	25	11	0	108	0	0
7	19	22	11	108	0	0
8	8	17	0	52	0	0
9	25	4	0	25	0	0
10	52	17	7	121	4	0
11	11	0	0	1300	0	0
12	22	7	18	57	0	0
13	14	11	0	41	7	0
14	30	0	0	78	4	0
15	22	11	0	60	0	0
16	56	14	0	63	0	0
17	43	23	0	120	0	3
18	93	10	0	214	0	3
19	30	10	0	250	0	0
20	27	10	7	487	0	3

The second line of endeavor was an attempt to learn what forms are pathogenic to wheat, which are found in the body of the kernel.

Method: Ten seeds were selected at random from seed plots 1 to 20. These were treated with one per cent formaldhyde (solution made by adding one cc. of commercial forty per cent formaldehyde to 100 cc. of distilled water.) These were treated with formaldehyde at this strength for one minute, then washed in sterile distilled water in order to wash off the formaldehyde. These seeds were then transferred to plates of sterile mannite agar, and incubated at 29°C. for seven days. Examinations were then made microscopically. Five of these sterilized seeds during the test

were placed on each plate. The plates developed the following results:

Plot No.	Alternaria sp.	Colletotrichum sp.	Macrosporium sp.	Fusarium sp.	Cephalothecium sp.	Helminthosporium sp.	Penicillium sp.
1	3	0	0	0	0	0	3
2	1	1	1	0	0	0	2
3	5	0	1	0	0	0	2
4	2	0	0	0	0	0	1
5	5	2	0	0	1	0	1
6	0	0	1	0	0	0	0
7	1	0	0	0	0	0	6
8	2	0	0	0	0	0	1
9	3	1	0	0	0	0	0
10	5	1	0	0	0	0	0
11	4	0	0	1	0	0	3
12	7	0	0	0	1	0	1
13	2	0	0	0	0	0	3
14	1	0	0	0	0	0	1
15	5	0	0	0	0	0	0
16	4	0	2	0	0	1	0
17	4	2	0	0	0	0	4
18	4	0	2	3	0	0	0
19	3	0	0	0	0	0	0
20	9	0	0	0	0	0	0

These two tables, as compiled, would seem to indicate that practically all of the fungi, which, in the previous work of this department have been shown to be capable of destructive work upon the roots of the wheat plant, reached the seed before it was mature, and in many cases as shown by the cultures, are undoubtedly internal within the body of the seed. Later work not yet compiled for publication shows that a very much larger percentage of the fungi are internally within the seed coats than are represented by the last table quoted above, the disinfecting treatment in this case being sufficiently strong to do away with all these

causes of infection which merely concern the seed coats. In most cases this treatment resulted also in a partial permeation of the embryo to such extent that a very high percentage of all the embryo plants were rendered non-viable.

The Relationship of Certain Weeds as to the Possibility of Carrying or in Part Supporting Wheat Fungi, by T. D. Beckwith, June 13, 1911: "The purpose was to learn what fungi appear upon wheat and common weeds associated with wheat grown under natural conditions on old wheat soil. (Plot 2 of Agricultural Department.)

Method: By the use of sterile instruments, sterilized in alcohol, sections were cut from various plants. These sections were then dropped directly without sterilization, onto mannite agar in tubes. The fungus growth which germinated on these sections of stems was given an appropriate time for development, and then examined microscopically. The idea on which the experiment was founded, was that using sterile instruments, no extraneous material would be taken from section to section, and the germinations, therefore, would show what forms were found on these plants. The idea was to learn if possible, something concerning possible methods of transmission of wheat diseases from crop to crop, by means of the growth of associated plants and weeds. The following table giving the specimen number, the plant from which section was taken and the fungi germinating upon the same, tabulates the results:

1 Wheat—Colletotrichum and Helminthosporium.
2 Pigeon grass—Colletotrichum.
3 Wheat (large plant)—Helminthosporium.
4 Iron Weed—Colletotrichum.
5 Wild Buckwheat—Nothing.
6 Rose—Penicillium.
7 Wheat—Nothing.
8 Pigeon grass—(first leaf)—Nothing.
9 Wheat—Colletotrichum and Helminthosporium.
10 Pigeon grass—Colletotrichum.
11 Wheat—Colletotrichum.
12 Oats—Colletotrichum.
13 Wheat—Helminthosporium.
14 Wild Buckwheat—Nothing.

15 Wheat—not determined.
16 Pigeon grass—not determined
17 Wheat—Helminthosporium.
18 Oats—Nothing.
19 Wheat—Colletotrichum.
20. Wheat—Helminthosporium.
21 Wheat—Nothing.
22 Wild Oats—Colletotrichum.
23 Iron Weed—Colletotrichum.
24 Wheat—Helminthosporium.
25 Wheat—Colletotrichum.
26 Wheat—Colletotrichum and Helminthosporium.
27 Wheat—Colletotrichum.
28 Wheat—Colletotrichum.
29 Lambsquarters—Colletotrichum.
30 Wheat—Nothing.
31 Wheat—Colletotrichum.
32 Wheat—Helminthosporium.

These figures seem to show that under the conditions of that wheat plot Colletotrichum in particular may quite commonly be found on certain weeds—notably wild oats, iron weed and pigeon grass.

Fungi Found in Soil of Wheat Fertilizer Plots Nos 1 to 20, Feb. 1, 1911 to July 1, 1911.

Method: Samples were taken under ordinary precautions for sterility, two inches below the surface. One gram of soil was weighed out carefully, mixed with ten c.c. of sterile distilled water until as even a suspension as possible had been gotten and then of this suspension one-tenth of a c.c. was mixed with another cc. of sterile distilled water. Plates were then poured from this dilution of 10,000 times—plates were incubated seven days—29°C. and microscopic examination was then made of fungus colonies; the pathogens were then tabulated as follows:

	February 7.	March 15.	May 1.	June 7	July 1.
1.		Colletotrichum	Fusarium		
2.		Colletotrichum Alternaria	Alternaria	Alternaria	
3.	Alternaria	Colletotrichum Alternaria			Alternaria Fusarium
4.	Colletotrichum	Alternaria	Colletotrichum	Alternaria Fusarium	Colletotrichum
5.	Colletotrichum	Colletotrichum	Colletotrichum Fusarium	Fusarium	
6.	Fusarium	Colletotrichum	Fusarium Colletotrichum	Fusarium	Colletotrichum
7.	Colletotrichum			Fusarium Colletotrichum	
8.	Verticillium		Fusarium Alternaria Colletotrichum	Fusarium	Alternaria Colletotrichum
9.	Fusarium Verticillium	Fusarium Alternaria		Fusarium	Alternaria
10.	Colletotrichum Alternaria	Alternaria	Colletotrichum		Colletotrichum Fusarium
11.	Fusarium		Colletotrichum	Colletotrichum	
12.		Alternaria	Colletotrichum Alternaria	Fusarium	
13.	Colletotrichum		Fusarium	Alternaria Colletotrichum	Fusarium
14.	Colletotrichum Verticillium	Alternaria	Colletotrichum	Fusarium Alternaria	Fusarium Colletotrichum
15.	Colletotrichum Alternaria	Colletotrichum	Fusarium		Alternaria
16.	Colletotrichum	Alternaria			Colletotrichum Fusarium
17.	Colletotrichum Alternaria	Colletotrichum	Colletotrichum	Colletotrichum	Alternaria
18.	Coletotrichum Alternaria	Colletotrichum	Fusarium	Alternaria Fusarium	Alternaria
19.		Alternaria	Colletotrichum	Colletotrichum	
20.			Colletotrichum		Alternaria

The results of these cultures should be contrasted with the results gained from the cultures from the wheat plants obtained on the same plots in previous reports."

These reports of culture study by Mr. Beckwith, when associated with our field work with fertilizers and our histological work upon wheat plants growing upon the various plots and when associated with the inoculation work upon soils and upon growing plants and seed brings me to the inevitable conclusion that all of the genera mentioned in this table persist in the soil of wheat plots, and indeed are sufficient in themselves to account for the deterioration of wheat quality and wheat yields upon old wheat soils. It is interesting to note that in this particular set of soil examinations Helminthosporium has not been recorded. The fungus which in our cultural work upon wheat straw is often met with and which we know is capable of destroying the wheat

plants, and which, in actual fact, is a common disease. It may be that it will yet be found that this fungus confines itself quite closely to the straw parts and that possibly it is more strictly a parasitic relying upon its association with the seed to bring about its distribution. More thorough study may possibly develop the fact that the culture media may account for its absence as noted here in the soil of beds upon which it is found that this genus has caused great destruction. Each of the genera mentioned, except Verticillium, is represented in our work by apparently one or more species. Until their life history in connection with other cereals is more closely known they are reported in our laboratory work by number and the genus.

Water Analyses—Bacteriological, 1910 by T. D. Beckwith: There is constant call for bacteriological analyses of waters. Usually the requests come from farmers. When the requests are from Boards of Health, the senders have been requested to report their difficulties to the State Board of Health Office at Grand Forks. We have, however, during the year 1910 conducted bacteriological analyses upon 31 samples of water from drinking supplies on various farms.

The results of these analyses show that many of the wells in farming districts are open to contamination from sewage and it is evident that in the location of wells on the farm, greater care should be practiced than is usually taken and every effort should be made to protect the supply from surface contamination. At the request of the city engineer of the City of Fargo Mr. Beckwith also made a series of bacteriological analyses of the water supply of the Red River as before reaching Fargo and after meeting with the sewage contamination of Moorhead and Fargo. These were taken at five different dates, Nov. 23, Dec. 11, Dec. 17, April 19 and May 5. The number of samples examined in all were 18. The detailed report of these analyses is unnecessary in this report but the results clearly indicate that the Red River water is unsafe for human consumption unless its use is safe-guarded in many ways. Nothing less than a very satisfactorily constructed filter, closely guarded from a bacteriological standpoint at all times, can justify the use of this water supply; and at no greatly distant date the citizens of the city should insist that this river be no longer made the

dumping ground for refuse and city sewage. The reports of these analyses are filed in the regular reports of the department.

Flax Diseases and Flax Croppings:—Because of added assistance which has lately been afforded to this department we have been able to carry on flax cropping experiments with regard to the flax crop and its diseases, including side lines in breeding experiments for the improvement of strains which this department has already developed and for the development of others. To this work, field assistant William Mercer has given very close attention and working upon the plans laid out has gained further information relative to both flax and wheat diseases, and the methods which must be pursued in order to avoid them. Close attention is given in this field experimental work to all details of culture to bring about the development of the strength of the crop.

The department has laid out careful experiments to test the oil producing capacity of certain strains and the fiber producing capacity of any or all of the strains. These lines of work are continued in conjunction with the regular cropping experiments and ought eventually to give us definite information as to whether it is possible to improve, by cropping methods, the quantity and quality of oil produced or the quantity and quality of fiber produced as easily as it is possible to develop plants of improved disease resisting ability.

Co-operative Work In Breeding and Distributing Flax Seed:—In our original work of co-operative flax seed breeding with farmers approximately 40 farmers received samples of resistant seed. During the spring planting of 1911 the persons planting resistant seed numbered something over 150. The results from this work of co-operative breeding of resistant seed has been very encouraging indeed. The work started in the spring of 1908 with no farmers possesing more than one-half bushel of seed. Several of the farmers during this season have raised over 2000 bushels of seed and it will be distributed to a very large number of growers.

One of the difficulties which we have had to contend with is that the old flax lands which the seed is used upon have become over run with weeds, especially pigeon grass

and mustard. Farmers sowing the resistant seed on this old land to prove its power of resisting disease, often place it in competition with a mass of weeds far in excess of that which any crop should be expected to withstand, and yet they almost unanimously report results beyond their greatest expectations. It is sometimes difficult to remove the weed seeds and thus the value of the seed as produced by some of them for distribution is very greatly reduced.

Another feature which is encouraging is that this great increase of resistant flax has been made during the three hardest years that the state has ever known for the production of flax, specially the seasons of 1909 and 1910, years when drouth and disease almost eliminated the ordinary crop in the sections where the farmers were trying this co-operative work.

Need of a Seed Growers' Association:—The feature which has been most discouraging to all parties concerned rests in the following facts viz., that **there is no reliable co-operation among the farmers regarding the growth of pure seeds or the breeding of pure seeds**. If a farmer produces a quantity of valuable seed bred from some experiment station number, upon which an immense amount of money has been expended to develop it, he finds himself alone and unable to sell the seed to anybody except the ordinary source of farm sales—the elevators and mills—and so the hard work of breeding is at once lost or wiped out. There should be formed as quickly as possible an association of seed growers in North Dakota, in every county of the state, which, in working together, may advertise each others products, so that a man who knows that he has seeds of high value can have a medium for making that fact known to the world. This could be done through a co-operative seed growers' association by means of the publication of a catalog of the growers each year. This would help the individual growers and would help the wholesale seed houses of the state and would eventually improve the standard of all seeds sown in the state, where otherwise the average farmer must continue to sow seeds such as are only fit for food or forage. Recognizing this fact we have started the organization of such an association, and at the late Grain Growers' Convention preliminary steps were taken for such a state associa-

tion to be affiliated with county organizations. When they are once in proper working order there would be little danger of such valuable strains of flax such as N. D. R. 73, or wheat such as Minnesota 169 being ground in the mills before but a few farmers have tried out their merits.

Under the proper workings of such an organization there will be a reliable source of seed from year to year in each county of the state.

Possibility of Breeding Wheats Resistant to Disease:—Working along lines similar to that through which we developed the various strains of resistant flax seed, I attempted to develop strains of wheat which would be resistant to rust. At first it appeared that progress was being made. Later, the combination of disease, rust, root-rot and blight essentially destroyed all strains. The work was continued and during the season of 1911 some strains of durum wheat and fife and one strain of velvet chaff were placed in the hands of farmers for trial to ascertain whether there is any indication that they had gained any hardiness. The reports are most encouraging, but it is not the intention of the department to give out any seed for general distribution until this question has been tested for a number of years. Such gain in hardiness as has been reported by the various co-operators may only be matters of accident. The problems involved are too complex to be dealt with as in the case with potatoes or flax, but our experiments working along the line of promoting the elimination of the weak by means of the introduction of disease has given much information which would tend to make one hopeful of gaining results in that line of work.

Internal Plant Feeding and Internal Medication:—A tentative line of experiments have been continued through the season using sunflower and field corn as subjects. Considerable data has been collected as to the possibilities of the work but I do not consider anything that we have done as a material advance on our work as recorded in the Fourteenth Annual Report and in the Eighth Biennial. Our present aim is to continue tentative experiments for the collection of data which will allow the planning of more effective work.

Work on Weeds:—The call for our publication known

as Bulletin 80 and the Press Bulletins issued since to aid in giving information without the expense of giving out the larger bulletin continues, altho the supply of Bulletin 80 has long since been reduced to a comparatively few numbers, so that it is only given out to those engaged in investigation work We have continued this year to conduct tentative experiments on methods of spraying for the purpose of the destruction of weeds of particular resistance to the ordinary spraying methods. We have also undertaken to develop some method of spraying which may be used upon lawns as a substitute for iron sulphate with the hope of preparing some solution that does not stain clothing, etc. It is possible that chloride of lime is going to be in large part satisfactory to use, but so far we have found no substance for controlling dandelions as effective as iron sulphate as recommended in our Press Bulletin 26. Some experiment stations that have made trials of the work which would hardly do credit to a school boy, when considered from the standpoint of efficiency, have essentially condemned the process of controlling dandelions in lawns by means of the spraying method. I believe that anyone who has inspected the Agricultural College grounds during the last two or three years and noticed their condition during the summer of 1911 must be reasonably convinced that something more than ordinary has been accomplished there with regard to the control of this pest. When I make this statement I hope that it will be understood that primarily weed spraying was developed for the control of annual weeds in grain fields. One must remember in working with the dandelion that it is a cosmopolitan weed, wind blown, and that the important question of control really centers on the point whether one would rather cut off the dandelions one by one six or seven times a year, or whether he would do that work by means of a traction sprayer or by means of a hand sprayer through the use of which one can cover an acre in the same time which it would take to cover a few yards of ground with a knife. The spray is more effective than the knife, for by its use the roots are actually destroyed by one to three applications, whereas the knife can be used bi-monthly and perennially and the same roots remain.

Aids for Farmers, Seedsmen and Teachers:—In carry-

ing out our work with seeds and weeds and plant diseases we are continually learning that it is difficult for the farmer, the busy teacher and the business man to grasp the work as laid down in bulletins, publications, etc. We have found it possible, by using the force of this department, working at odd times when other work is not pressing, to put together a number of collections which are sold to teachers, seedsmen and other citizens of the state at approximately the cost, not considering the thought and time placed on it by the regular professors or assistants. These collections have been received with a great amount of enthusiasm, especially by the teachers. We have placed out Weed Seed Collections Nos. 1 and 2, showing 52 of the most common characteristic species of weed seeds. We have prepared a plant disease collection No. 1 showing 20 of the most destructive crop diseases of the state. The specimens are prepared so that they may serve as illustration, and so that the teachers and others may know by looking at them how they may procure more for class work. We have also prepared a collection of 26 specimens of the weeds of North Dakota, seedlings and mature weeds corresponding with Weed Seed Collection No 1. This latter collection, because of its cost, will be distributed only to schools, so that its usefulness may be made available to a large number of persons. The seedsmen of the state have very generally made use of the weed seed collections, making use of them in their business of purchasing seeds.

Many of the teachers of the state are called upon to teach agriculture. They come to the school after the snow has fallen on the ground and leave again by the time the snow disappears. They have but few supplies of any sort for illustrating their work, and such collections as we have mentioned should prove of great aid in the instruction of agriculture in the rural schools and agricultural high schools. That they are so appreciated is indicated by the fact that they are purchased in most cases more rapidly than we can put up the collections without increasing the cost. School boards wishing to obtain these collections should apply to Secretary W. A. Yoder of the Agricultural College.

Soil Survey Work:—The economic plant survey is being continued and is in part carried out in conjunction with the work of the economic and geological survey of the institu-

tion. Professor Bergman spent the summer of 1911 in the field making a careful survey of the native plants found upon the areas surveyed by the geologists under the direction of Professor Hard.

A careful record is also kept of all the plants collected throughout the state, including disease producing organisms and the bacterial flora as reported in the soil survey. A number of our workers also spend a part of the summer months in crop inspection work for plant diseases. This data is each year tabulated and will eventually be compiled and published in the Biennial Report in connection with the geological survey, and such parts of it as are directly applicable to the work under way will also be used in connection with the data of our regular experiments.

Professor Bergman is gradually listing and classifying data with regard to the native plants of the state with a view of reediting Bulletin 46—Seed Bearing Plants of North Dakota. When this publication is ready for issue it is my opinion that it will prove one of the most valuable additions to our agricultural literature for the aid of teachers in public schools and especially the rural schools. A report of the year's work upon the plant collections has been submitted by Professor Bergman. The same has been filed and will be included in the next Biennial Report.

Result of Use of Formaldehyde in the Treating of Flax Seed for the Prevention of Wilt and Canker:—During the present year we have received many hundreds of letters from farmers explaining the results which they have obtained in the treatment of flax seed for the prevention of wilt. The results as gleaned from the letters from farmers on this point are extremely encouraging. It is evident, from the results reported by the farmers and from our own experimental work, that seed sanitation or proper seed grading and seed treatment is the primary and most essential step in the controlling of destructive root diseases. Many farmers are of the opinion that seed treatment persisted in year by year is the only thing that is necesary. However, a careful survey of the replies indicate that the best results will only be obtained by those who, in association with proper seed treatment, maintain also a rather persistent though flexible crop rotation. Many have asked us what this crop

rotation should be. Our study of the question, plus the reports from the farmers, indicate quite closely that we can write four of the crops in the series as follows: Grass, pasture, corn, flax and wheat. Later information may allow us to extend this series or indicate ways in which it might be varied with profit .

Miscellaneous studies upon Wheat and Other Cereal Diseases:—Since September, 1910, I have had associated with me in this department, Mr. D. G. Milbrath, and much of the data reported in the following pages has been worked out by him under plans which we have together formulated with a view of gaining more accurate knowledge of the causes underlying deterioration in quality and yield of cereal grains, and I herewith append some of the data accumulated by Mr. Milbrath.

Cultures to Determine the Cause of the Brown Spot on the Stem of Wheat Plants:—The term "Brown Spot" is one chosen arbitrarily to mark out an infection of that color on the lower portion of wheat stems near the soil line.

The area of infection embraces an extent beginning at a point one-half inch below the uppermost cycle of roots and extending upwards over a distance of one and one-half inches to two inches.

The effect of this infection was evident after a careful investigation of growing plants in the field. Wheat plants infected usually consisted of one stool and rarely more than two. In many cases evidence of arrested stooling could be found. In such instances the growth of the stool had been intercepted often in the bud and frequently after reaching the length of an inch. It is important to note here that point of stool formation is located in that area above described as infected area.

The effect upon the vascular system of the wheat stem will be shown in a subsequent report.

The material for this work was obtained from the Experiment Station Rotation Plot No. 2, the Movius Land Company farm, Lidgedwood, N. D., Adam Hass' farm, and Titus Bros.' farm Edgeley, N. D., from a farm near Kenmare collected by Professor Bolley and from farms near Casselton collected by Mr. Campbell.

Method: A portion of infected stem, after washing in

3-1000 formaldehyde solution, was placed in Mannite agar culture tubes. The tubes were permitted to remain in refrigerator at approximately 4 to 8°C for a period of two months.

Two examinations of the total number of 324 tubes revealed 310 growths of moulds.

The results are given in the attached table. (The letters in the various columns are the initial letters of the various genera of fungi—located in the specimens.)

TABLE OF BROWN SPOT RECORDS.

Wheat Stubble—Crop 1911.

Record No.	Pathogenic Fungi Obtained in Pure Form	Record No.	Pathogenic Fungi Obtained in Pure Form
1	M, H	163	H, F
2	H	164	M
3	H	165	H, (Pure) A, C, F
4	H, Asp.	166	H, F
5	M, A	167	H, Asp.
6	M	168	H, A
7	M	169	H, F
8	A, H	170	H, C, F
9	—	171	H, C, F
10	M	172	H, M
11	H, F	173	M, C, H
12	M, A	174	H, C
13	H	175	F
14	A	176	H, M
15	C, A	177	H. F
16	H	178	H
17	H, A	179	H, F
18	H, M, A	180	H, C
19	H, F	181	H, F, O
20	M	182	H, C
21	H, F	183	H
22	H, C	184	H, M, F
23	H, M	185	C, F, O
24	H	186	H, F
25	H, A	187	H, F
26	H, M	188	H, A
27	H, F	189	H, C
28	F, H, M	190	H
29	A	191	H, (Pure)
30	F, M	192	M, C
31	H, F	193	H, F
32	M, F	194	H, (Pure)
33	F	195	H, F
34	H	196	H, M, F
35	F, H	197	H
36	H, M	198	H, M
37	M, F, A	199	H, (Pure)
38	H	200	H, F

Record No.	Pathogenic Fungi Obtained in Pure Form
39	H
40	H, M
41	F
42	H, F
43	F
44	F, H
45	H, F
46	H, M
47	M
48	H
49	F
50	F
51	F, H, M, C
52	H
53	H, M
54	H, M
55	H, M
56	F, H
57	Pen., F
58	H, C (Pure)
59	H, A
60	H, F
61	H, F
62	H, F
63	H, F, A
64	H, A
65	H, M
66	M
67	H, F
68	F
69	H, F
70	C, F
71	H, A, F
72	H, M, F
73	H
74	H, M, C, F
75	H, A
76	F, O
77	M, H
78	M
79	M, H, A
80	H
81	H, M, F
82	H
83	H, A, F
84	H, M, F
85	H
86	H
87	H, F
88	H (Pure)
89	H, F, O
90	H, M
91	H, F
201	H, M
202	H, (Pure)
203	H
204	H, F
205	H, F
206	H
207	H
208	H, M, F
209	—
210	H, C
211	H
212	H, M, F
213	H, C, A
214	H
215	H, (Pure)
216	H, M, F
217	H, M
218	H, M, F
219	H
220	H, F, Asp.
221	H, F
222	H, F
223	H
224	H, (Pure)
225	H, F
226	H, C
227	H, A, F
228	H, F
229	H, F
230	H, M
231	H, C
232	H, (Pure)
233	H, F
234	—
235	H
236	H, F
237	H, A, F
238	H
239	H
240	H, (Pure)
241	C
242	H, C
243	H, A, F
244	H, (Pure)
245	—
246	H
247	H, O, F
248	—
249	H, M
250	H, F
251	H
252	H
253	H

Record No.	Pathogenic Fungi Obtained in Pure Form
92	H
93	—
94	H
95	H, M
96	H, F
97	F, H, C
98	H, F
99	H, F
100	H, C, F
101	M, H
102	H, M
103	H
104	H, F
105	F, H, M, C
106	M
107	H
108	H
109	H
110	H, C
111	H, M
112	—
113	H, A
114	—
115	M
116	C, H, F, M
117	H, F
118	—
119	—
120	M, H
121	H, M, F
122	F, H
123	H, C
124	M
125	H, F, M, C
126	H, (Pure)
127	H, M
128	F, M, A
129	H
130	H, M, A
131	—
132	—
133	—
134	—
135	H, M, F, C
136	H
137	H, M, F
138	H
139	H
140	H, M, F, O
141	H, M, F
142	H, A
143	H, F
144	H, F
254	H
255	H, F
256	H, F
257	H, F
258	H
259	H, M, F
260	H, F
261	H, F
262	H, F
263	H, F
264	H, F
265	H, F
266	H, F
267	H. F
268	H
269	H, F
270	H, F, C
271	H, F
272	F
273	H, F
274	H, C, F
275	H, F
276	H, F
277	H, F
278	H, F
279	H, F
280	H
281	H, F, C
282	H, F
283	H
284	H
285	F
286	H, A, F
287	H, M, F
288	H
289	H, F
290	H
291	H, A
292	H, F
293	H, M, F
294	H, F
295	H
296	H, F
297	H, F
298	H, F, A
299	H
300	H
301	H, F
302	H, F
303	H, F
304	H, F
305	H, A
306	H, F

Record No.	Pathogenic Fungi Obtained in Pure Form	Record No.	Pathogenic Fungi Obtained in Pure Form
145	H, M, C	307	H
146	H	308	H, F
147	H	309	H
148	H, M	310	H, Asp.
149	H, M	311	H, F
150	H	312	H
151	H	313	H, C
152	H, M, F, C	314	H, F
153	H, M	315	H, F
154	H, F	316	H, F
155	H	317	H, M, F
156	H, M, F	318	H
157	H, F	319	H
158	H, M, F	320	H, A
159	H	321	H, M, F
160	H, F	322	H, F, C
161	H	323	H, F
162	H	324	H

From the above 324 specimens 201 were plated out in petri dishes. From the growths on these dishes a second set of tubes were made; and it was from the examinations made on these two sets of tubes which furnished the data for the construction of the table.

The following summary indicates the comparative prevalence of the various genera of the imperfect fungi which are now known to cause root diseases and soil sickness with reference to wheat. In the work of making pure cultures a number of peculiar features were noticed which indicate the characteristic of the various fungi but this cannot well be reported at this time. The fungus here marked "O" is an exceedingly destructive one and the genus name is withheld until more conclusive data has been obtained as to its identity.

The following summary shows the comparative prevalence of the different forms: Macrosporium, 79; Helminthosporium, 273; Alternaria, 32; Colletotrichum, 38; Fusarium, 149.

It is extremely difficult in ordinary culture examinations to be always certain of the distinction between the genus Macrosporium and the genus Alternaria. It is possible that further studies of these cultures will change the relation of the numbers with reference to these two genera. I have gone over all of these cultures with Mr. Milbrath, and

also made a study of the lesions or brown spots, and it would seem evident from the results obtained that the characteristic brown colored spots on the foot of the culm of wheat and barley plants may be due to either Macrosporium Helminthosporium or Alternaria, and quite commonly to two or more species of fungi present at one and the same time. This brown spot lesion for the present cannot be looked upon as diagnotic of any particular one of the imperfect fungi, though Helminthosporium and Alternaria are specifically indicated by our investigation along another line of work.

"Investigation of Winter Wheat Culms to Determine the Cause of Brown Discoloration:—The material for this work was obtained from Agricultural Department winter wheat plot 1912 crop. On this plot corn had been cropped in the season of 1911. The plants were collected October 17, 1911. The brown discolored part of the culm, in all instances located near the ground line where the roots (uppermost) emanated, was cut off and washed for one minute in a 3-1000 formaldehyde solution. Each specimen was not of greater length than one centimeter.

Mannite agar according to Lipman's formula was employed. Sixty-two plants were under trial. The results of these cultures were as follows: Out of the sixty-two cultures the genus Fusarium was taken in 19 cases. Helminthosporium in 6, Colletotrichum in 10, Macrosporium or Alternaria in 22, Penicillium in 1, Aspergillus in 7 and unknown Spherical Brown spores in 12. In some cases the infections overlapped.

"Internal Infection of Embryo of Wheat:—In previous preliminary work with wheat grains, thoroughly sterilized on the outside and as far internally as such disinfectants ordinarily penetrate, such treated grain after insertion in sterilized media often produced moulds of the types common in this study.

The aim in this work was a determination of the possibility of embryo infection. The seeds were soaked in distilled water for 24 hours, the embryo was then removed and disinfected with 2½-1000 corrosive sublimate for two minutes.

A medium of potato starch was employed to supply ap-

proximately the same conditions existing in the endosperm and starch cells of the wheat kernel.

The above work was done on December 21, 1911. Results on February 5, 1912 were as follows: All seeds selected had been distinct cases of Black Point on the germ end.

No.	Source of the Seed	Fungus
1	McLeod, Alberta	Alternaria
1 C	McLeod, Alberta	Alternaria
2 A	Red Durum, Bolley	Helminthosporium
2 B	Red Durum, Bolley	Helminthosporium
2 C	Red Durum, Bolley	Helminthosporium
3 A	Pewe, Durum, McHenry, N. D.	Alternaria
3 B	Pewe, Durum, McHenry, N. D.	Alternaria
4	Rebhahn, Durum	Helminthosporium
5	No. 5943	Alternaria, Bacteria
6	No. 6013	Alternaria, Bacteria
7	No. 5732	Alternaria, Bacteria
8	No. 6047	Fusarium
9	No. 5873	Helminthosporium
10	No. 5973	Fusarium, Bacteria
11	No. 5872	Helminthosporium, Bacteria
12	No. 6003	Alternaria, Bacteria
13	No. 5922	Alternaria, Bacteria

Summary: Alternaris, 9 cases; Helminthosporium, 6 cases; Fusarium, 2 cases; Total trials 29.

Centrifuge Test of Wheat Seed from Crop of 1911:— The object of this test is to gain a survey of the comparative prevalence of certain fungi known to internally infest the seeds of approximately normal wheat grains. These tests are based upon the original methods by Professor Bolley in his work upon the study of smuts in cereal grains during the seasons of 1890 to 1897, and which have been found to be of much importance in diagnosing the causes of plant diseases. As in that case the work resulted in sufficient definiteness to allow me to select the samples to illustrate the internal infection of embryoes as is indicated in preceding paragraphs.

Method: Five cubic centimeters of the grain to be tested were washed and shaken in ten cubic centimeters of distilled water in a shell vial. The liquid was poured into a centrifuge tube. The results of the centrifuge tests are as follows:

DATA ON CENTRIFUGE TESTS WITH WHEAT SEEDS

Grower	Region	Kind	No.	SPORES—10 READINGS NUMBER AND KINDS
H. Lentz	Taylor, N. D.	Fife	5797	Rust 11, Macrosporium 8
		Bluestem	5745	Rust 13, Macrosporium 23, Smut 1
		Velvet Chaff	5767	Heterosporium 1, Fusarium 1, Cephalothecium 67, Rust 3, Macrosporium 19, Smut 1
Rebhahn		Durum	5777	Rust 5, Macrosporium 15, Smut 2
Waldron	Dickinson, N. D.	Durum	DES 713	Macrosporium 1, Rust 4
H. Bouse	Wolsey, S. D.	Bluestem	5817	Cephalothecium 35, Macrosporium 2, Helminthosporium 1, Rust 80, Tilletia 56
F. S. Chamberlain	Doyon, N. D.	Fife	5805	Rust 7, Macrosporium 17, Tilletia 2
		Fife	5826	Macrosporium 2
Jos. Stengele	Cooperstown, N. D.	Bluestem	5861	Rust 33, Macrosporium 48, Tilletia 1, Smut 1
Pewe		Durum		Rust 3, Macrosporium 28, Helminthosporium 1
S. Galloway	Mandan, N. D.	Wheat	5873	Rust 7, Cephalothecium 22, Alternaria 15, Smut 3, Fusarium 1
		Durum	5819	Alternaria 8, Cephalothecium 1, Fusarium 1, Smut 1, Helminthosporium 1
Adam Gabe	Taylor, N. D.	Velvet Chaff	6008	Alternaria 2, Rust and Smut, Helminthosporium 1, Colletotrichum 18, Fusarium 1
P. Pearson	Cooperstown, N. D.	Bluestem	5863	Helminthosporium 3, Alternaria 3, Rust
H. Lentz	Taylor, N. D.	Fife	5901	Colletotrichum 10, Macrosporium 3, Rust
H. Lentz	Taylor, N. D.	Bluestem	5900	Alternaria 1, Arthrobtryis 1, Rust, Macrosporium 2, Fusarium 1, Colletotrichum 6
H. L Bolley	A. C.	Durum 75		Helminthosporium 2, Cephalothecium 11, Alternaria 3, Macrosporium 1
P. Pearson	Cooperstown N. D.	Bluestem	5865	Helminthorporium 1, Fusarium 1, Colletotrichum 1, Macrosporium 1, Alternaria 8, Arthrobotryts 1
Adam Gabe	Taylor, N. D.	Bluestem	6007	Macrosporium 3, Alternaria 1, Arthrobotrytis 1
H. Lentz	Taylor, N. D.	Bluestem	5926	Macrosporium 2, Spherical spores
H. Lentz	Taylor, N. D.	Bluestem	5927	Rust, Macrosporium 2, (Spherical spores),
L. C. Bullock	Pleasant Lake	Durum	5872	Arthrobotrytis 7, small spherical spores, Alternaria 12, Macrosporium 1, Helminthosporium 2
A. D. Dibbern	Litchfield, N. D.	Bluestem	5732	Helminthosporium 1, Cephalothecium 6, Macrosporium 9, Alternaria 10
		Velvet Chaff	6047	Alternaria 6, Arthrobotrytis 2, Macrosporium 1, Fusarium 4, Cephalothecium 3
M. F. Swanston	Michigan, N. D.	Velvet Chaff	5913	Macrosporium 1, Helminthosporium 1, Alternaria 19, Arthrobotrytis 1
A. A. Robinson	Minot, N. D.	Fife	5803	Alternaria 7, Macrosporium 4
Wm. Johnson	Douglas, N. D.	Bluestem	5673	Macrosporium 22, Helminthosporium 1, Alternaria 21
		Bluestem	5973	Alternaria 22, Macrosporium 13, Arthrobotrytis 1, Cephalothecium 18, Acrothecium 1, Helminthosporium 1, Fusarium 1
		Bluestem	5922	Macrosporium 10, Cephalothecium 16, Colletotrichum 2, Fusarium 1, Alternaria 2
M. C. Bean	Wheelock, N. D.	Bluestem	5763	Macrosporium 4, Alternaria 2, Cephalothecium 2, Fusarium 1, Colletotrichum 1, Acrothecium 1

Report on Fungus Content of Specimens from Territories Outside of North Dakota, by D. G. Millbreath:—Wheat stubble received from J. T. Pridham, Agricultural Station, Dooen, Victoria.

Method of examination: Disinfected surface of stem and roots with 3-1000 formaldehyde solution. Placed specimen in tube of mannite agar carefully sterilized.

Results: The following spores and their mycelia were developed—Alternaria, Colletotrichum and Ophiobolus graminis or "Take-all."

Quack-grass, collected by Bolley, Janesville, Wisconsin, October 22, 1911, in corn field: Helminthosporium, Fusarium and Bacteria.

Wheat stubble,Mrs. J. H. Loomis, Janesville, Wisconsin: Helminthosporium, Alternaria, Fusarium and Bacteria.

Rye stubble, Wisconsin Experiment Station Farm, Madison, Wisconsn: Alternaria and Bacteria.

Barley, Volunteer plants, collected by Bolley, Janesville, Wisconsin, October 22, 1911: Helminthosporium and Alternaria.

Barley, Volunteer in winter rye, collected by Bolley, Janesville, Wisconsin, October 22, 1911: Helminthosporium.

Quack-grass, Janesville, Wisconsin, collected by Bolley from timothy field: Fusarium and Helminthosporium

Wheat—"White Belly" Seeds under Culture Method. (Nov. 17, 1911.)

Grains of wheat selected from No. 2289 Kubanka Durum, Crop 1910, Farm Department, North Dakota Agricultural College. Dipped the grains in 3-1000 formaldehyde solution for 3 minutes. Used mannite agar. Twenty-seven seeds were examined in this test, being typical "White Belly" grains. The results of the cultures obtained were as follows: Macrosporium or Alternaria in 24 cases, Fusarium in 1 case, Helminthosporium in 1 case, Aspergillus in 5 cases and Bacteria in 3 cases.

It is evident from the numerous investigations of the department, that the so called "White Belly" or piebald

wheat is closely related to certain biological conditions, but these results obtained by Mr. Milbrath are not sufficient to allow us to draw any conclusion.

Investigation of Pinkish Colored Seeds of Wheat by Culture Method:—Grains of wheat selected from Bed 20, Crop 1910, Wheat Fertilizer Plots. Dipped grains in 3-1000 formaldehyde solution for 3 minutes, mannite agar medium. Twenty-eight separate specimens were placed under culture conditions, and the fungi separated were as follows: Macrosporium 11 cases, Helminthosporium 1, Bacteria 11, Fusarium 4, Brown spherical spores 3.

Red Color of Wheat and Oat roots:—Material selected from Farm Rotation Plot No. 2, July 18, 1911.

Method: Mannite agar medium in culture tubes, kept in refrigerator at approximately 6°C.

Examination, Oct. 12, 1911 Tube 1, Fusarium spores—Bacteria; Tube 2, Fusarium spores—few Macrospores; Tube 3, Fusarium; Tube 4, Fusarium, (chlamydospores) and mycelium; Tube 5, Fusarium mycelium and accessory spores; Tube 6, Fusarium spores, Bacteria; Tube 7, (9-10-10) Bacteria, Fusarium chalamydospores. Alternaria; Tube 8, (9-10-10) Helminthosporium on red sheath, Fusarium on roots.

Oats—Red Roots:—A, C. Farm 9-3-10; Tube 1, Starch medium, Fusarium Bacteria; Tube 2, Sugar medium Alternaria Bacteria; Tube 3, Apple medium, Fusarium mycelium, Colletotrichum (?) Bacteria; Tube 4, Oats from Corn Field —Red Roots (a) Fusarium, Helminthosporium; (b) same as (a). Tube 5, Oats stubble from Valley City by Bolley 9-13-10 (a) Bacteria, Alternaria, Fusarium (Chlamydospores) (b) Fusarium, Colletotrichum. Oats—Old Corn Field, 9-13-10: Fusarium hyphal and Chlamydospores.

The conclusions to be drawn from these results are that the peculiar coloration associated with the dying roots of cereals, is probably brought about by the action of one or more species of the genus Fusarium. This is in large part confirmed by the culture experiments and inoculation experiments of this department not yet published.

Corrosive Sublimate as a Disinfectant of Wheat Seeds: During the years of 1890 to 1897, working upon smuts of

cereals, this department developed what is known as the corrosive sublimate treatment. In work upon wheat it proved to be a most effective treatment for the production of a clean crop and good yield in the Red River Valley. On account of the poisonous nature of the corrosive sublimate, effort was made to procure another substance for disinfecting seed grains, and this department in 1897 published the formaldehyde treatment, which, since that time has become a universal treatment for seed grains. While very satisfactory for general farm work, it has in some respects with wheat not given as good results as the corrosive sublimate. It is probable that on account of the peculiar nature of the root-rot diseases of wheat, corrosive sublimate will be found to be a very satisfactory treatment for the purpose of purifying seed for sowing purposes, due to its lasting effect on the seed coats. For this reason a new set of disinfecting experiments have been undertaken. The following table compiled from work of Mr. Milbrath indicates that Alternaria is going to prove to be a very resistant disease, but that it will probably be possible to eliminate essentially all of the others on reasonably plump dry wheat. The Alternaria seems to be very persistent and situated internally.

The seeds for this work were obtained from the Dickinson Sub-Station, crop of 1911, and were hand picked to normal heavy weight grains, exceeding 62 pounds per bushel.

Kind of Seed	Concentration of $HgCl_2$	Period	Number of Seeds	Number germinated	Germination Percentage
Kubanka	2½-1000	20 m	484	260	53.7%
Red Fife	2½-1000	20 m	222	98	44.1%
No. 663 Bluestem	2½-1000	20 m	149	97	65.1%
Red Fife	2½-1000	15 m	580	487	84%
Red Fife	2-1000	15 m	398	366	92%

Purity Tests:—The following table shows the purity attained by this method of disinfection.

Kind of Wheat	Number of Tubes	Number Infected 20 days later.	Kind of Infection	Purity%
Kubanka	75	24	22 Alternaria 2 Bacteria	68%
Red Fife and Bluestem	68	34	32 Alternaria 2 Bacteria	50%

Examination of Quack-grass, Other Grasses and Weeds for the Determination of Parasitic Fungi, October 24 1911:—Approximately one-half inch of the root or of the underground root stalks were taken and disinfected exteriorally by 3-1000 formaldehyde for 20 seconds and placed in mannite agar tubes. The growths obtained gave the following results:

Tube 1, Brome grass—Volunteer A. C. farm, Fusarium spores; Tube 2, Brome grass—Volunteer A. C. farm Colletotrichum; Tube 3, Podosphaera oxyacantha—Farm Plot No. 2, Macrosporium; Tube 4, Quack-grass—Slough, Fusarium spores; Tube 5, Spartina sp, Farm Plot No. 2, Fusarium spores; Tube 6, Agropyron tenerum A. C. Farm, Fusarium, Colletotrichum; Tube 7, Brome grass—Volunteer A. C. Farm, Macrosporium; Tube 8, Wild Barley, Fusarium; Tube 9, Brome grass, Fusarium; Tube 10, Agropyron tenerum, Fusarium; Tube 11, Brome grass, Fusarium; Tube 12, Brome grass, Fusarium; Tube 13, Brome grass, Fusarium; Tube 14, Agropyron tenerum, Slough, Fusarium; Tube 15, Agropyron tenerum, Macrosporium; Tube 16, Agropyron tenerum, Fusarium. Tube 17, Agropyron tenerum, Fusarium; Tube 18, Quack-grass, Sanger, N. D., Fusarium, Helminthosporium; Tube 19, Quack-grass, Sanger, N. D., Macrosporium; Tube 20, Quack-grass, Sanger, N. D., Helminthosporium; Tube 21, Quack-grass, Sanger, N. D., Helminthosporium, Macrosporium; Tube 22, Quack-grass, Sanger, N. D., Macrosporium; Tube 23, Quack-grass, Sanger, N. D., Macrosporium; Tube 24, Quack-grass, Sanger, N. D., Macrosporium.

It is evident that in the cereal disease infected soils many roots may bear fungi of the same genera. It is interesting to note that the Fusarium, the characteristic wheat disease, is a common outgrowth from root stalks of Agropyron repens (Quack-grass). This has been reported from this department under other circumstances.

WORK OF THE PURE SEED LABORATORY.

The farmers and local seedsmen of the state have taken a great deal of interest in the Pure Seed Laboratory and have made much use of the same. The appropriation furnished by the state has been sufficient to pay the salary of one expert and keep the equipment of the laboratory in good shape, and allow us to publish small circulars calling attention to the conditions under which the citizens of the state may make use of the laboratory. Private aid for this work has allowed us to very greatly extend the work and usefulness of the laboratory. There has been some slight complaint that the inspection is not as persistent and as thorough as it should be. We have, however, used a system of checking up buyers and sellers which largely takes the place of actual field inspection, at much less cost. The writer believes that we have been able to give great aid both to farmers and seedsmen in laying in their stock of seed. If more thorough field inspection is needed than has been accomplished during the two preceding years, it will be necessary to have an additional appropriation for this field inspection work.

Report of the Pure Seed Laboratory—July 1, 1910 to July 1, 1911, by O. A. Stevens and J. R. Campbell:

"Equipment: Several important pieces of apparatus have been added to the equipment of the laboratory during this period. These include a mixer and a vertical air blast separator of the type recommended by the Association of American Agricultural Colleges and Experiment Stations. The value of the air blast separator can hardly be over estimated. The labor saved by its use would probably equal its cost in a comparatively short time. This is leaving out of consideration an inestimable saving of eye strain when small seeds are involved.

Another very important addition is a Leitz binocular microscope. This is equipped with a full set of lenses (4 pair of objectives and 3 pair of oculars) giving magnifications ranging from somewhat above that of an ordinary magnifying glass to about the lowest power of the usual

compound microscope. On account of the very large working distance of the instrument it is especially well adapted to the study of seeds and for dissection of small flowers, etc. by reflected light. We find that it is exceedingly useful for making measurements of the smaller seeds. By attaching a camera lucida to the ocular and using transmitted light, the image may be projected to the table and upon an ordinary metric rule. The exact size may then be found by dividing the result by the magnification. With any but the smallest seeds a somewhat simpler method is to use a rule which has been constructed to a scale of the magnification, so that the readings are made direct. This instrument thus furnishes a rapid and very accurate method of measuring seeds which are not larger than about 6mm.

A closed balance, sensitive to one-half milligram has also been added to the equipment.

TEST OF SEEDS.

The number of samples of seeds received during this period may be summarized as follows:—

1.	Submitted for identification	60
2.	Submitted for purity and germination tests (field seeds)	2814
3.	Submitted for germination tests (field seeds)	116
4.	Submitted for germination tests (garden seeds)	492
5.	Submitted for germination tests (flower seeds)	112
6.	Collected by inspectors (field seeds)	635
7.	Collected by inspectors (garden seeds in bulk)	62
8.	Collected by inspectors (garden seeds in commission packets)	376
9.	Collected by inspectors (lawn grass mixtures)	34
	Total	4701

1. SUBMITTED FOR IDENTIFICATION.

This list contains a total of 146 identifications of seeds of 60 species of weeds and other plants. The more important of these included five identifications of Quack-grass and eleven of the Wheat grasses (Agropyron occidentale and

tenerum) so often confused with it; ten of Wild Oats, and five of common oats which were usually dark colored or awned forms mistaken for wild oats; four of Darnel (Lolium temulentum) found in oats which had been shipped into the state.

2 AND 3. FIELD SEEDS SUBMITTED FOR PURITY AND GERMINATION TESTS.

The following table presents a summary of the number of samples of these seeds sent by farmers and dealers, and the average percentage of purity and germination of each kind.

TEST OF FIELD SEEDS.

Kind of Seeds.	Number of Samples test'd	Average Purity. % of Pure Seed	% of Foreign Seed	% of Trash	Average Germination. % of Pure Seed Germinating	% remaining hard at end of test
Alfalfa	178	98.4	.7	.9	77	17
Barley	31	98.0	1.1	.9	87	--
Bluegrass, Canada	19	81.7	4.6	13.7	67	--
Bluegrass, Kentuc'y	17	81.0	.5	18.5	57	--
Bluegrass and Redtop	1	89.0	1.0	10.0	44	--
Bromegrass	108	74.6	2.4	23.0	76	--
Cane	1	----	---	----	20	--
Clover, Crimson	1	99.3	.4	.3	53	12
Clover, Alsike	84	93.8	4.9	1.3	79	19
Clover, Red	194	96.9	2.0	1.1	85	10
Clover, White	13	92.8	6.1	1.1	67	24
Corn	102	----	---	---	86	--
Cow Peas	1	----	---	---	90	--
Emmer	3	93.0	6.7	.3	95	--
Fescue, Sheep	3	86.0	.2	13.8	57	--
Flax	1554	93.4	.9	5.7	84	--
Hog Pasture Mixture	1	----	---	8.2	88	--
Lawngrass	3	----	---	23.6	70	--
Millet, Common	57	96.3	3.4	.3	84	--
Millet, Brome Corn	7	99.0	.8	.2	85	--
Millet, Japanese	3	98.1	1.9	trace	75	--
Oatgrass	1	90.2	5.0	4.8	95	--
Oats	113	97.7	1.8	.5	89	--
Orchardgrass	2	90.4	.2	9.4	69	--
Rape	11	----	---	---	83	--
Redtop	33	83.3	7.2	9.5	80	--
Rye	2	96.9	2.0	1.1	90	--
Ryegrass, Perennial	2	97.7	.7	1.6	72	--
Shaftel	1	95.5	.5	4.0	99	0
Timothy	105	96.1	1.2	2.7	88	--
Timothy and Alsike Clover	13	95.0	3.3	2.7	87(T) 69(al)	-- 14
Timothy & Red Clover	2	97.6	1.5	.9	96	--
Vetch	1	----	---	---	98	--
Wheat	359	97.8	1.0	1.2	88	--
Wheatgrass, Slender	8	86.5	1.4	12.1	88	--

The frequency of the chief weed seeds is shown in the following table.

CHIEF WEED SEEDS—NUMBER OF SAMPLES IN WHICH FOUND.

Name of Weed Seed.	Alfalfa 178 samples	Brome grass 108 samples	Alsike Clover 34 samples	Red Clover 131 samples	Flax 1554 samples	Millet 57 samples	Oats 113 samples	Timothy 105 samples	Wheat 359 samples
Catchfly (Silene noctriflora)	2	--	15	44	--	--	--	9	--
Cockle, Corn (Agrostemma githago)	--	2	--	--	35	--	21	--	138
Cockle, Pink (Vaccaria vaccaria)	2	4	--	66	--	--	8	1	60
Crabgrass (Syntherisma sanguinalis)	--	--	2	5	--	9	--	2	--
Crabgrass, Small (Syntherisma linearis)	1	--	--	14	--	6	--	--	--
Darnel (Lolium temulentum)	--	--	--	--	--	--	9	--	3
Doc, (Rumex sp)	19	8	5	26	11	1	2	6	--
Dodder, Field or other large seeded species (Cascuta arvensis and C. sp).	8	--	--	5	2	--	--	--	--
Dodder, Small seeded Alfalfa (Cascuta planiflora)	20	--	--	--	--	--	--	--	--
Evening Primrose (Onegra biennis)	--	--	--	24	15	--	--	37	3
False Flax (Camelina sativa)	--	3	--	--	30	--	--	1	5
False Flax, Round Seeded (Camelina dentata)	--	--	--	1	326	--	--	--	3
Frenchweed (Thlaspi arvense)	1	1	--	--	17	--	--	10	4
Hare's-ear Mustard (Conringia orientalis)	3	2	1	1	159	1	8	10	46
Kinghead (Ambrosia trifida)	--	--	--	--	12	--	1	--	10
Lambs Quarters (Chenopodium album)	116	19	--	85	861	25	18	65	83
Marsh Elder (Iva xanthiifolia)	13	--	--	--	20	--	1	--	--
Mustard, Indian (Brassica juncea)	14	5	--	1	448	2	18	2	32
Mustard, Yellow (Brassica arvensis)	7	4	2	1	64	1	22	9	16
Peppergrass (Lepidium apetalum)	4	4	14	4	11	1	--	54	4
Pigeongrass, Green (Chaetochloa viridis)	61	12	5	99	458	43	19	39	39
Pigeongrass, Yellow (Chaetochloa glauca)	5	4	--	22	223	33	14	3	7
Pigweed (Amaranthus retroflexus)	10	1	3	--	140	3	7	--	1
Plantain (Plantago major and P. rugelii)	3	1	3	39	5	--	--	16	--
Plantain, Lance leaved (Plentago lanceolata)	12	--	--	7	1	--	--	1	--
Pontentilla (Potentilla monspeliensis)	5	--	3	11	6	--	--	43	3
Quack-grass (Agropyron repens)	--	53	--	2	5	--	7	2	11
Ragweed (Ambrosia artemisiaefolia)	--	2	--	16	61	14	2	--	3
Rose (Rosa arkansana)	--	9	--	--	65	--	29	--	41
Russian Thistle (Salsola tragus)	58	1	--	2	406	5	2	--	24
Smartweed (Polygonum hydropiper, lapathifolium and persicaria)	--	4	--	25	58	19	7	1	--
Sorrel Dock (Rumex acetosella)	3	1	16	31	2	--	--	10	--
Sow Thistle (Sonchus arvensis)	--	--	--	--	--	--	--	1	--
Sweet Clover, (Melilotus sp.)	63	1	--	2	2	--	--	--	--
Thistle, Canada (Carduus arvensis)	1	--	2	4	13	--	--	2	1
Thistle, Prairie (Carduus undulatus)	--	3	--	--	22	--	--	2	6
Tumbling Mustard (Sisymbrium altissimum)	3	5	--	--	102	--	1	10	16
Tumbleweed (Amaranthus graecizans)	2	1	--	--	74	5	--	2	1
Wild Barley (Hordeum jubatum)	8	7	--	--	6	--	--	3	1
Wild Buckwheat (Polygonum convolvulus)	23	20	--	5	496	4	44	3	138
Wild Oats (Avena fatua)	--	4	--	--	190	1	63	3	85

The entire list of foreign seeds is too lengthy to present in this report. For the above seeds the total number of species of foreign seeds was: Alfalfa, 100; Brome grass, 103;

Alsike Clover, 30; Red Clover, 97; Flax, 122; Millet, 43; Oats, 40; Timothy, 90; Wheat, 62.

In a previous report of this laboratory (Tenth Biennial Report of the Agricultural College and Experiment Station p. 98) there were published some notes on the purity and germination of field seeds submitted for testing. Many of these need not be repeated here, as they will apply equally well to the samples listed above. The following table shows the rate at which some of these seeds were present in the samples in which they were found.

Name of Field Seed	Name of Weed Seed	No. of samples containing less than 100 seeds per pound	Samples containing 100 or more seeds per pound.		
			No. of samples	Largest No. per lbs. in one sample	Average No. per pound
Alfalfa	Small seeded Dodders	14	6	19,080	4,125
	Large seeded Dodders	4	4	900	450
	Sweet Clover	15	46	5,580	630
	Lance-leaved Plantain	8	4	1,170	450
Barley	Wild Oats	17	2	200	150
Bromegrass	Quack-grass	9	47	6,880	2,400
Alsike Clover	Catchfly	0	15	3,150	900
	Sorrel Dock	3	13	49,250	11,025
White Clover	Lance-leaved Plantain	1	4	1,125	2,250
	Sorrel Dock	0	9	34,425	4,945
Red Clover	Catchfly	19	29	5,400	1,050
	Dodder	2	2	225	270
	Lance-leaved Plantain	8	12	675	3,600
	Sorrel Dock	7	21	25,650	2,475
	Canada Thistle	2	2	270	270
Flax	False Flax	*206	*150	5,356	*306
	Hare's-ear Mustard	*130	*29	4,635	*972
	Musard (B. juncea and arvensis)	*304	*208	4,950	*450
Oats	Darnel	7	1	576	576
	Quack-grass	5	2	600	480
	Wild Oats	56	8	960	440
Redtop	Milfoil	0	26	80,000	13,950
Wheat	Corn Cockle	128	10	544	248
	Wild Oats	75	15	960	336

*Calculated on 200 per pound instead of 100.

In addition to the above table the following notes will explain some additional points and some which might otherwise be misunderstood.

Canada Bluegrass:—An occasional seed of Canada Thistle was found in nine samples, and nearly all of the rest contained undeveloped seeds or prickles of the same plant. The high percentage of foreign seed is largely due to timothy which in eleven samples comprised from 3% to 7.5% of the whole.

Brome grass:—The seeds of Western and Slender wheat grass which are hard to distinguish from Quack-grass, were

found in 22 samples, both being often found together. The high percentage of trash is largely due to the fact that many of the samples were uncleaned.

Alsike Clover:—Two samples contained seeds of Canada Thistle, five contained from 2% to 8.8% of white clover, and six from 1.2% to 26.3% of timothy.

Red Clover:—The two samples containing Quack-grass are from the same lot of seed but sent by two different parties. The seeds were nearly all hulled, very few of them having the perfect glume and palet attached. Several pounds of the seed was obtained from which sixty perfect seeds and two entire spikelets were secured. The embryo of a large number was injured but a germination test showed several per cent to be capable of growing. In one lot the seeds were present at the rate of 7000 and in the other about 14,000 per pound.

White Clover:—Canada Thistle was once found. Alsike clover constituted 1.5% to 9.9% of seven samples and timothy 3.9% of one and 4.1% of another.

Emmer:—This is usually called Speltz which is a different thing.

Flax:—A large number of samples of uncleaned seed were examined which accounts for the high percentage of trash. The predominence of **Brassica juncea** over **B. arvensis** is noteworthy as the latter has been considered the common species. In the same way **Camelina dentata** appears to be more common than **C. sativa.**

Lawngrass:—One sample consisted of chaffy redtop only.

Millet:—In five cases the amount of Green Pigeongrass ranged from 8.8% to 22.9%, and in one there was 25% of Yellow Pigeongrass.

Oats:—The presence of Darnel is to be noted. So far as could be ascertained the oats containing the seeds of this plant had been shipped in from another state.

Redtop:—The percentage of foreign seed is high on account of the frequency of considerable amounts of timothy. In sixteen samples this quantity varied from 1.3% to 28%, the average of these being 12.3%.

Timothy and Alsike Clover:—Attention has been called previously to the fact that the proportions in these mixtures are greatly variable. In the thirteen samples examined the percentage by weight of timothy ranged from 55.4% to 89%, averaging 74.1%; that of alsike ranged from 3.5% to 39.6%, averaging 18.1%.

Fig. 1. Showing Canada Thistle, and its permanent habit of sub-surface rooting.

4 AND 5. GARDEN AND FLOWER SEEDS SUBMITTED FOR GERMINATION TESTS.

Results of these tests are presented in the following tables:

GARDEN SEEDS—SUBMITTED FOR TEST.

Kind of Seed.	No. of Samples	Average of Germination	No. of Samples Germinating 90% or above	No. of Samples Germinating Below 50%
Artichoke	2	82	0	0
Asparagus	3	62	1	1
Anise	2	71	0	0
Beans	12	69	0	2
Beets	15	spr 117 B-53	12-0	5 1
Brussels, sprouts	1	75	0	0
Carrot	29	58	0	8
Cabbage	32	83	14	2
Catnip	1	0	0	1
Caraway	1	74	0	0
Cauliflower	5	70	1	1
Celery	16	32	0	13
Chervil	3	33	0	2
Citron	5	79	4	1
Corn salad	1	11	0	0
Cress	2	52	1	1
Cucumber	26	86	19	2
Dill	2	47	0	1
Endive	2	83	1	0
Egg Plant	1	44	0	1
Fennel	2	39	0	2
Garden Lemon	3	97	3	0
Hoarhound	1	3	0	1
Hyssop	1	60	0	0
Kale	2	58	0	1
Kohl rabi	2	62	1	1
Lavender	2	14	0	2
Lettuce	35	72	19	8
Leek	4	60	0	1
Mangel Wurzel	4	spr 88 B-48	s. 3 b-0	s. 0 b-2
Muskmelon	21	89	12	0
Mustard	2	52	1	1
Okra	1	28	0	1
Onion	42	82	17	2
Parsnip	7	49	0	4
Parsley	3	31	0	3
Pepper	5	81	2	0
Peas	6	92	5	0
Pumpkin	12	83	6	0
Rutabaga	8	85	3	0
Radish	55	94	37	1
Rosemary	1	12	0	1
Salisify	6	94	5	0
Saffron	1	43	0	1
Sage	2	52	0	0
Spinach	6	51	0	2
Sweet Peas	10	51	0	5
Sweet Majoram	3	57	0	1
Savory	2	43	0	2
Squashes	18	79	4	0
Sunflower	3	91	2	0
Sweet Corn	5	73	1	0
Thyme	2	64	0	1
Tobacco	1	39	0	1
Turnip	11	77	9	0
Tomato	28	83	12	1
Watermelon	13	87	8	0
Wormwood	2	7	0	2
TOTALS	492		188	84
TOTAL AVERAGE		75		

SAMPLES SUBMITTED—FLOWER SEEDS.

Kind of Seed.	No. of Samples	Average of Germination	No. of Samples Germinating 90% or above	No. of Samples Germinating Below 50%
Ageratum	1	15	0	1
Alyssum	4	66	1	2
Antirrhinum	1	61	0	1
Aster	6	47	0	4
Balsam	5	87	3	0
Bachelor Button	1	49	0	1
Calliopsis	1	69	0	0
Catchfly	1	35	0	1
Canary Bird Flower	2	40	0	0
Candytuft	4	69	1	1
California Poppy	7	71	0	2
Convolvulus	1	48	0	1
Cypress Vine	4	59	1	1
Canterbury Bells	2	44	0	2
Dandelion	1	0	0	1
Daisy	3	72	0	0
Dianthus	2	80	0	0
Four O'Clock	3	72	0	0
Forget-me-not	2	5	0	2
Gourd	1	75	0	0
Hollyhock	2	39	0	1
Heliotrope	1	11	0	1
Ice Plant	1	52	0	0
Larkspur	1	4	0	1
Marigold	3	38	0	2
Mignonette	2	52	0	1
Morning Glory	2	45	0	1
Nasturtium	6	21	0	5
Pansy	13	60	0	4
Primrose	1	0	0	1
Portulaca	3	81	1	0
Poppy	2	76	1	0
Pink	1	88	0	0
Petunia	3	61	0	0
Phlox	1	9	0	1
Pyrethum	1	0	0	1
Star Flower	2	22	0	2
Sweet William	3	68	1	0
Verbena	4	30	0	3
Zinnia	3	88	1	0
Stock	3	39	0	2
Salpiglossis	1	64	0	0
TOTALS	112		11	46
TOTAL AVERAGE		53		

6. INSPECTION OF FIELD SEEDS OFFERED FOR SALE.

As in the preceding year an inspection of seeds sold throughout the state was made during the months of March, April and May. On account of the great amount of work at this time of the year it was possible only to make germination tests ,and examinations for such seeds as Quack-grass, Dodder, etc. The following table presents a summary of these tests.

INSPECTION OF FIELD SEEDS ON LOCAL MARKET.

Kind of Seed.	No. samples collected by inspectors	Average per cent of germination	UNFIT FOR SALE	
			Number	Reasons
Alfalfa	33	86 (6 hard)	3	Dodder
Barley	12	89	0	
Bluegrass, Canada	1	72	0	
Bluegrass, English	1	30	0	
Bluegrass, Kentucky	23	40	0	
Brome grass	20	78	6	Quack-grass
Buckwheat	1	61	0	
Clover, Alsike	21	85 (9 hard)	0	
Clover, Red	47	87 (5 hard)	1	Dodder and Canada Thistle
Clover, White	22	67 (22 hard)	1	One for large amount of Sorrel Dock, Lance-leaved Plantain
Corn	127	88	3	Germination 47, 34 and 15% respectively
Emmer	1	93	0	
Field Peas	16	84	0	
Flax	32	88	0	
Hog Pasture Mixture	1	81 (Average)	0	
Meadow Fescue	1	0 "	1	Germination 0
Millet, Common	90	89	2	Germination 20 and 27%
Millett, Brome Corn	15	84	0	
Millet, Japanese	3	78	0	
Oats	33	83	0	
Rape	19	65	3	Germination 11, 8, 0%
Redtop	18	84	0	
Rye	2	91	0	
Timothy	51	91	1	Canada Thistle
Timothy and Alsike	1	(26 T, 15 A)	1	Low germination
Timothy and Redtop	2	-----	--	
Timothy & White Clover	1	(72 T, 62 W-C)	0	
Vetch	1	98	0	
Wheat	39	90	2	One for large amount Pink Cockle and Wild Oats. One for large amount Pink Cockle, Mustard, Corn Cockle
Wheat-grass	4	80	0	

In December 1910, Pure Seed Circular No. 3 was issued calling attention to the fact that the law forbids the sale of seeds containing seeds of Dodder, Quack-grass, Canada Thistle and Sow Thistle. It also stated that in the following year (1911) the names of firms offering seeds of low quality would be published. This circular was addressed particularly to firms in other states who ship their seeds into this state. In the following list are given the names of other parties offering the lots indicated in the preceding table as unfit for sale. In behalf of the local dealers who offered these seeds for sale it should be stated here that they were

unaware of the quality of the seed and upon being notified of the same promptly withdrew the seed from sale. No cases of intentional violation of this clause of the law have come to notice.

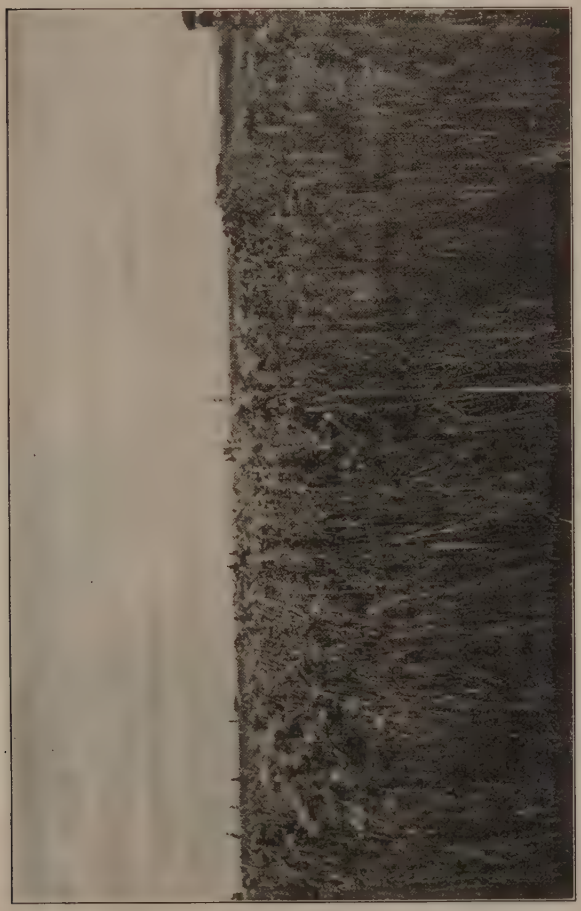

Fig. 2. Wheat Field overrun by Canada Thistle.—Photograph by Bolley.

SEEDS INSPECTED AND FOUND UNFIT FOR SALE.

Record No.	Kind of Seed	Offered by	Secured by Dealer From
5292 Alfalfa	Dodder	H. L. Haussamen & Co., Grafton, N. D.	Northrup, King & Co., Minneapolis, Minn.
5405 Alfalfa	Dodder	G. A. Bodmer, Kenmare, N. D.	Northrup, King & Co., Minneapolis, Minn
5461 Alfalfa	Dodder	Kensal Imp. Co., Kensal, N. D.	unstated
3550 Brome grass	Quack-grass	Dickinson Merc Co., Dickinson, N. D.	Northrup, King & Co., Minneapolis, Minn.
4382 Brome grass	Quack-grass	Magill & Co. Fargo, N. D.	Jas. Holland, Bismarck, N. D.
5048 Brome grass	Quack-grass	Magill & Co. Fargo, N. D.	A. F. Kyle, Gladstone, N. D.
5216 Brome grass	Quack-grass	C. H. Baker, Devils Lake, N. D.	Northrup, King & Co., Minneapolis, Minn.
5406 Brome grass	Quack-grass	G. A. Bodmer, Kenmare, N. D.	L. P. Jensen, Kenmare, N. D.
5407 Brome grass	Quack-grass	P. Bertelson, Kenmare, N. D.	The Albert Dickinson Co, Minneapols, Minn.
5460 Red Clover	Dodder	Kensal Imp. Co., Kensal, N. D	Northrup, King & Co., Minneapolis, Minn.
5213 White Clover	Many seeds of Sorrel Dock	C. H. Baker, Devils Lake, N. D	Northrup, King & Co., Minneapolis, Minn.
G1435 Corn	Germination 15%	Geo. Drenkel, Dickinson, N. D.	Walter Palmette, Manning, N. D
G1575 Corn	Germination 34%	H. Kelly, Jamestown, N. D.	Northrup, King & Co., Minneapolis, Minn.
G1557 Corn	Germination 47%	Edgeley Feed Mill., Edgeley, N. D.	Minneapolis Seed Co., Minneapolis, Minn.
4615 Meadow Fescue	Germination 0	H. Kelly, Jamestown, N. D.	Northrup, King & Co., Minneapolis, Minn.
3572 Common Millet	Germination 20%	Overstadt & Hoverson, Beach, N. D.	Farmer Seed Co., Fairbault, Minn.
5219 Common Millet	Germination 30%	C. H. Baker, Devils Lake N. D.	Northrup, King & Co., Minneapolis, Minn.
5316 Common Millet	Germination 27%	G. W. Foogman, Grafton, N. D.	L. L. May & Co., St. Paul, Minn.
G1886 Rape	Germination 0	R. C. Lindsey & Co., Page, N. D.	Northrup, King & Co., Minneapolis, Minn.
G1664 Rape	Germination 11%	A. D. Sprague, Devils Lake, N. D.	D. M. Ferry Seed Co., Detroit, Mich.
G1569 Rape	Germination 8%	H. Kelly, Jamestown, N. D.	Northrup, King & Co., Minneapolis, Minn.
5317 Timothy	Canada Thistle	G. W. Foogman, Grafton, N. D.	F. J. Coba
5223 Timothy and Alsike	Germination Alsike 15% Germination Timothy 26%	C. H. Baker, Devils Lake, N. D.	Northrup, King & Co., Minneapolis, Minn.
3562 Wheat	Many seeds of pink and white cockle	Richardton Milling Co., Richardton, N. D.	unstated
3566 Wheat	Many seeds of pink cockle and wild oats	Farmers' Elev. Co., Richardton, N. D.	unstated

7. INSPECTION OF BULK GARDEN SEEDS.

The following table presents the results of germination tests of bulk garden seeds taken by the inspectors in the local markets.

BY INSPECTION—GARDEN SEEDS IN BULK.

	No. of Samples	Average Germination	No. of Samples Germinating 90% or Above	No. of Samples Germinating Below 50%
Beet	2	54-31	0-0	1-2
Bean	1	80	0	0
Carrot	1	65	0	0
Cabbage	2	85	1	0
Cucumber	2	94	1	0
Mangel Wurzel	7	44-21	1-0	6-7
Onion	3	89	2	0
Peas Garden	6	61	2	3
Peas—Sweet	2	81	0	0
Radish	4	92	3	0
Rutabaga	3	85	1	0
Sweet Corn	22	82	7	0
Turnip	5	53	1	2
Pop Corn	2	85	1	0
Totals	62		19	14
Total Average		71		

Commission Seeds: The inspectors purchased during April and May, 376 packages of these seeds. As certified by the dealers, they were received that year. These represented 23 lots put up by 9 firms. By comparing with similar tests made the preceding year, (See Biennial Report p. 110, 1910) the standing of most of the firms represented will be seen to remain about the same.

	Crossman Bros.		Dunkirk Seed Co.		Farmer Seed Co.		D. M. Ferry Seed Co.		Guerney Seed & Nursery Co.		Northern Seed Co.		Northrup King & Co.		J. B. Rice Seed Co.		M. L. Webster Seed Co.		Totals and Averages	
	No. Pkg. Tested	Av. % Germination	No. Pkg. Tested	Av. % Germination	No. Pkg. Tested	Av. % Germination	No. Pkg. Tested	Av. % Germination	No. Pkg. Tested	Av. % Germination	No. Pkg. Tested	Av. % Germination	No. Pkg. Tested	Av. % Germination	No. Pkg. Tested	Av. % Germination	No. Pkg. Tested	Av. % Germination	No. Pkg. Tested	Av. % Germination
Beans	2	50	3	70	1	74	3	79	1	2	2	93	3	88	2	91	1	90	18	74
Beet	4	89 48	4	94 54	4	95 62	9	109 66	1	118 78	2	40 32	10	111 60	4	132 63	1	128 80	39	105 60
Cabbage	3	60	4	10	2	70	10	84	1	95	1	99	6	90	2	73	1	81	30	72
Carrot	1	1	1	24	4	78	8	64	1	69	2	49	10	47	2	67	1	69	30	56
Celery	1	9	1	2	3	46	3	10	1	43	2	76	2	67	0	0	1	15	13	37
Cucumber	2	33	4	61	4	92	11	86	2	67	2	85	8	88	--	65	1	94	37	82
Ground Cherry	0	--	0	--	0	--	0	--	0	--	0	--	1	51	0	--	0	--	1	51
Lettuce	1	40	3	88	4	86	8	96	1	96	3	99	8	87	2	81	1	97	31	89
Onion	3	1	3	40	4	74	11	85	2	92	3	88	9	84	4	51	1	94	40	70
Parsnip	2	8	1	0	3	39	2	36	1	46	2	29	3	44	2	45	1	0	17	31
Peas	0	--	1	72	1	98	1	76	0	--	1	96	2	67	0	--	0	--	6	79
Radish	3	53	3	90	4	84	8	95	2	70	4	94	10	80	4	71	1	73	39	82
Rutabaga	2	63	0	--	3	94	3	95	0	--	2	78	1	75	2	40	1	83	14	77
Sweet Corn	2	70	1	83	1	86	3	84	1	84	1	80	5	82	2	69	1	42	17	77
Tomato	2	58	1	55	3	87	3	84	2	94	4	88	3	87	2	43	1	96	21	78
Turnip	3	43	1	32	3	72	5	93	1	99	2	77	4	98	2	54	1	62	22	74
*Totals and Averages	31	41	31	46	44	78	88	81	17	74	33	81	85	76	33	62	14	68	376	71

*The total average per cent of germination is obtained by adding the figures for each test and dividing the sum by the number of the samples tested.

9. LAWN GRASS MIXTURES.

The nature of these mixtures is such that a special method of presenting the results of tests is necessary. Since it is rarely stated what kind of seed they contain it is impossible to determine the amount of pure seed. Also as they usually contain a mixture of several different kinds of small seeds, and often a large amount of fine chaff, it requires an enormous amount of time to make a complete analysis. In compiling the following list therefore, we have merely made a careful examination to determine the principal components, and the most important weed seeds. Particular pains have been taken to determine whether Kentucky or Canada Blue-grass was present, and if both, the relative amount of each. This is an important point, as the two grasses are not of the same nature or value. The seed of the Canada Blue-grass is much cheaper and may be used as an adulterant. It also often contains seeds of Canada Thistle.

Commission Packages:—Of these packages which are put up with the commission boxes of garden seeds, nine were examined, the results of which are as follows:

Crossman Bros., Rochester, New York:

No. 4200 ½ Mainly Blue-grass and Redtop, some white clover and timothy.
Blue-grass is 10% Canada.

No 4400 1-3 About the same but Blue grass all Kentucky.

D. M. Ferry Seed Co., Detroit, Mich:

No 4200 1-3 Blue-grass, redtop, ryegrass and some timothy, white and alsike clover.
Blue-grass about half Canada.

Farmer Seed Co., Fairbault, Minn:

No. 4600 1-3 Redtop, ryegrass, blue-grass, white clover, timothy and alsike.
Blue-grass all Kentucky.

No. 4885 Same.

No. 4325 Same, but blue-grass one-fourth Canada. Contained **Canada Thistle.**

Northrup King & Co., Minneapolis, Minn.:

No. 4000 ½ Mainly Redtop, also perennial ryegrass, blue-grass and some white and red clover and timothy. Blue-grass all Canada. Contained **Canada Thistle.**

No. 4205 Same as 4000 ½.

No. 4308 Same as 4000 ½.

Here should be included also a package (labelled one quart) sold by F. W. Woolworth & Co., of Fargo, N. D. Put up by Whitney-Eckstein Seed Co., Buffalo, N. Y.

No. 5375 Redtop only: about half by weight chaff.

LAWN GRASS IN BULK.

In the following list these samples are grouped under the name of the party or firm furnishing the seed

THE ALBERT DICKINSON CO., MINNEAPOLIS, MINN.

4840 Offered by Wahpeton Hdw. Co., Wahpeton, N. D., Redtop, perennial ryegrass, blue-grass and timothy. Blue-grass in one-half Canada. Contained much Potentilla and mature seeds of **Canada Thistle.**

5482 Offered by Joos Merc. Co., Wimbledon, N. D., Canada bluegrass, redtop, perennial ryegrass. Contained many seeds of Potentilla and several immature ones of **Canada Thistle.**

MAGILL & CO., FARGO, N. D.

4886 Offered by H. Miller & Co., Wahpeton, N. D., Kentucky bluegrass, redtop and white clover.

5500 Offered by Stoudt & Co., Page, N. D., Redtop and white clover only.

JOHN O. HALVORSEN, WILLISTON, N. D.

4598 Offered by City Feed Store, Williston, N. D. bluegrass, redtop, perennial ryegrass and white clover. Bluegrass is four-fifths Canada. Contained an immature seed of **Canada Thistle.**

NORTHRUP, KING & CO., MINNEAPOLIS, MINN.

3548 Offered by Dickinson Merc. Co., Dickinson, N. D., perennial ryegrass, and redtop, Kentucky bluegrass and white clover.

3549 Offered by Dickinson Merc. Co., Dickinson, N. D., same as last.

4400 Offered by D. E. Lewis, Fargo, N. D. Kentucky bluegrass, redtop, sheep fescue, dog's tail grass, white clover.

4530 Offered by W. D. Campbell, Edgeley, N. D., perennial ryegrass, Kentucky bluegrass, redtop, sweet vernal grass, dog's tail grass.

4541 Offered by Ellendale Grain & Produce Co., Ellendale, N. D., Kentucky bluegrass, redtop, perennial ryegrass, white clover, dog's tail grass.

4592 Offered by G. M. Hedderick & Co., Williston, N. D., redtop, bluegrass, perennial ryegrass, white clover. Bluegrass is one-sixth Canada.

4629 Offered by H. Kelly, Jamestown, N. D., redtop, bluegrass, perennial ryegrass, dog's tail grass, white clover. Bluegrass is one-half Canada.

5013 Offered by Central Hardware Co., Mayville, N. D., redtop, bluegrass, perennial ryegrass, white clover. Bluegrass is one-third Canada.

5019 Offered by Central Hdw. Co., Mayville, N. D., perennial ryegrass, sheep fescue, Kentucky bluegrass, redtop, dog's tail grass, white clover.

5028 Offered by Hansen & Hansen, Mayville, N. D., redtop, bluegrass, perennial ryegrass, white clover. Bluegrass is half Canada.

5196 Offered by C. P. Brainerd, Devils Lake, N. D., perennial ryegrass, redtop, Kentucky bluegrass, dog's tail grass, white clover.

5199 Offered by C. P. Brainerd, Devils Lake, N. D., Kentucky bluegrass, redtop, perennial ryegrass, sheep fescue, dog's tail grass, white clover.

5299 Offered by H. L. Haussamen Co., Grafton, N. D., perennial ryegrass, Kentucky bluegrass, redtop, dog's tail grass, white clover.

5300 Offered by H. L. Haussamen Co., Grafton, N. D., Kentucky bluegrass, perennial ryegrass, redtop, white clover.

5313 Offered by G. W. Foogman, Grafton, N. D., Kentucky bluegrass, redtop, perennial ryegrass, dog's tail grass.

5459 Offered by Kensal Impl. Co., Kensal, N. D., redtop, bluegrass, perennial ryegrass. Bluegrass is one-fourth Canada. Contained an unfilled seed of **Canada Thistle**.

4407 Offered by N. J. Olsen & Co., Fargo, N. D., redtop, bluegrass, white clover. Bluegrass is half Canada. Contained an unfilled seed of **Canada Thistle**.

4408 Offered by N. J. Olsen & Co., Fargo, N. D., timothy, redtop, white clover, Kentucky bluegrass.

These two lots were the only ones which were labeled with the names of the components, but the kind of bluegrass was not indicated.

4605 Offered by A. A. Robinson Elev. Co., Minot, N. D., Kentucky bluegrass, redtop, perennial ryegrass.

3592 Offered by Vallancey Bros., Mandan, N. D., bluegrass redtop, sheep fescue. Bluegrass one-half Canada.

Summary: From the foregoing it will be seen that the composition of "lawn grass" is quite variable, that Canada bluegrass is often substituted in part or entirely for Kentucky bluegrass; two samples contained no bluegrass at all; Canada thistle seeds were found in several samples, sometimes well developed seeds, more often undeveloped.

FIELD AND GARDEN WORK.

In addition to seed testing in the laboratory a report should be here made of a number of investigations in the field and in garden plots.

Field Inspection of Brome Grass:—So many letters were received inquiring where good seed of brome grass could be secured that an attempt was made during the summer to ex-

amine a large number of fields in order to ascertain whether fields free from quack-grass could be located, and seed obtaind from them. By means of a circular letter quite a number of fields in various localities were mapped for inspection.

Two inspectors were kept in the field for this purpose most of the time from June 19 to July 28, and twenty-one towns, mostly along the lines of the Soo and Northern Pacific railroads, were visited. Thru the hearty cooperation of interested parties in each town it was possible to visit the fields for several miles on each side.

In all, 65 fields were examined, aggregating 3530 acres, the fields varying in size from two or three acres to two and three hundred acres. The general results were as follows:

Apparently free from quack-grass,	30 fields,	1830 acres
With small amounts of quack-grass,	27 fields,	1250 acres
With large amounts of quack-grass,	8 fields,	550 acres

These figures agree very well with our records of the occurence of the seeds in samples of brome grass, showing that the danger of introducing this pest has not been overestimated.

Those fields listed as containing large amounts of quack-grass had conspicuous dense patches of several feet in diameter, occurring every rod or two. Those which contained small amounts had scattered patches that were poorly defined or consisted of only a few scattering stalks. In the latter case the detection of the quack-grass was quite difficult, as often it could be seen only at a distance of a few feet. The constant presence of the native wheat grasses, particularly the Western wheat grass, also compelled a rather close examination of the plant in many cases, altho the difference in general appearance is usually enough to distinguish them at some distance.

These badly infested fields as far as could be ascertained were fields which had been spring plowed a year or two before. Apparently the quack-grass does not usually develop dense patches but has a better chance to do so when the brome grass is partially killed by cultivation.

A number of fields not seeded to brome grass were seen in which the presence of quack-grass was probably due to a former seeding to brome grass. A few were seen where the

introduction must have been by other means; in one of these five or six acres were completely occupied by the quack-grass and many more contained patches.

These records added to numerous identifications of plants sent from various places show the presence of quack-grass in nearly every county of the state east of the Missouri river and in some of the adjoining counties to the west.

New Weeds:—We desire to call attention to a new mustard which has been found along the railroad at Fargo and has been sent in from one place north of Fargo. This is **Erucastrum pollichi** Schimp and Spenn, a European plant allied to our common mustards previously reported in this country only from Wisconsin and Massachusetts.* It was first found at Fargo in October, 1909, (O. A. Stevens), appears to be well established and perhaps a permanent addition to our already large list of mustards. In appearance it considerably resembles Tumbling Mustard. The leaves are quite similar but darker green and with rounded lobes. The flowers are similar, but the pods are more like those of the common yellow mustard except smaller. The seeds are two or three times as large as those of Tumbling Mustard, oblong, reddish yellow, and faintly reticulated.

On May 26, 1911, several small seedlings were taken up and placed in a plot in the testing garden. Altho given very little attention, they grew vigorously, producing the first flowers June 25. The first pods were scattering seed a month later and shortly after this half a dozen plants were harvested for seed, producing one and a half ounces of clean plump seed. One plant cut off near the ground sent up new shoots but did not mature seed before frozen. The plants growing along the railroad have been found with the first flowers about the middle of June and flowering vigorously when the first freeze comes in the fall

Another plant which has not been yet reported from this state, but which may be looked for is Perennial Pepper-grass (**Lepidium draba L.**) better designated perhaps as **Cardaria draba** L. Desv.) This is a European plant which has been reported in this country from a few widely separated locali-

*Rhodora 13: 10 Jan. 1911.

ties. The seeds are quite common in Turkestan alfalfa and a garden test has shown that the plant gives promise of being a bad weed on account of its vigorous reproduction by underground shoots like Canada Thistle.

Early in the spring of 1910 several plants were started in the greenhouse, the seeds having been taken from alfalfa seed. On account of the very backward weather the plants were not placed out doors until quite late, and were almost immediately subjected to the unusual summer, having almost no rain. That fall they were supposed to be dead, but early the next spring not only did the original plants begin to grow, but new plants began to appear at distances of several feet from the original ones. By the end of the season a large number of plants had appeared on all sides of the original ones and to a distance as great as eight feet. A few flowers appeared early in the season on the original plants, but only one or two pods were formed and no seeds produced.

The plant is rather bushy, only a foot or so high; leaves similar in shape to those of Frenchweed, but gray and rough; flowers white, about the size of those of Frenchweed; pods ovoid neither flattened nor winged; seeds oblong, something like those of Frenchweed but a little smaller, dull reddish brown and smooth.

Variety Tests:—Nearly one hundred plots of oats were planted in an attempt to segregate the named varieties into groups of similar forms. These comprised nearly fifty named varieties obtained from twenty-one of the principal seed firms doing business in this secton. A preliminary study in the field resulted in these being divided into eleven groups, most of which were quite distinct. Others were not so readily separable, and the varieties included in each group were apparently very similar.

Plantings of varieties of alfalfa were also made with a view of ascertaining how closely this type of seed is sold to name. Results from this work of course cannot be obtained the first year."

Hard Seeds of Clover and Alfalfa:—Preliminary Trials of Treatments to Improve Germination:—In previous annual reports, notably 1909, of this station we have noted that

many seeds in ordinary samples of alfalfa and clover will not germinate under ordinary conditions, either in the germination pans or in the soil. For a number of years we have been making a number of preliminary experiments to ascertain whether some treatment can be developed for such samples of clover and alfalfa seed which will facilitate the germination of the hard seeds without injury to the germination of those seeds which are viable. It has been apparently proven that the reason the seeds do not germinate rests in the fact that they have a more resistant seed coat than ordinary seeds. Ordinarily dry land northwestern grown alfalfas contain a higher percentage of hard seed than similar varieties grown in more moist districts. It is also apparently true that the valuable variety known as Grimm is apt to have a very high percentage of these hard seeds. Our experiments tend to show that such hard seeds under their natural conditions are of but little value to the farmer, as they do not germinate with sufficient regularity or sufficiently early to aid him in securing a stand. By treating such samples containing hard seeds the writer believes that the germination record of the first ten days will give the essential value of a particular variety of seed so far as the individual farmer is concerned, inasmuch as he is buying the seed for the purpose of getting a stand capable of holding the ground against the weeds.

This, however, does not change the fact that those hard seeds are strong viable seeds. If they could be made to germinate without injury to the others it would be a matter of great importance, because the price of alfalfa seed is apparently becoming higher and higher each year, so that the first cost to the farmer for a stand of alfalfa is very considerable. For this reason I have caused a number of experiments to be carried on with a view of gaining information on this point and will append here the data showing the results obtained in these preliminary treatments.

Experiments to Test the Growth of Hard Seeds in Soils of Different Quality in Greenhouse, February 28, 1910:— Thirty-one pots of soil were prepared as follows: Soil selected, ordinary wheat land of the Red River Valley on which had been continuous wheat croppings for something over 30 years, (Rotation Plot 2, Agricultural College), two lots of

ordinary yellow clay of the Red River Valley taken fresh from a depth of 29 feet, and pure sand from gravel pit, Muskoda, Minnesota. These soils were treated in various manners as described in the following numbers: The hard seeds were obtained from a sample of Trail County grown medium red clover, known in our seed laboratory as the "E. Y. Sarles" sample, seed laboratory record No. 103. The average viability of this sample during the period of our investigations was approximately 78%, hard 20, dead 2. Large quantities of this seed were exposed to germination in the standard seed tester of the pure seed laboratory for 5 days. Those remaining hard were selected for the experiment air-dried and planted. During the time that this experiment ran the soils of the pot were subjected to all sorts of watering conditions. At times they were evenly watered for a month, and at other times they were allowed to dry until the soil was as dry as the humidity of the greenhouse would permit. The object of this was to give varied conditions of soil to ascertain if germination would follow. The figures at the head of the columns indicate the dates on which new plants germinated and were removed.

POT EXPERIMENTS IN CULTURE HOUSE—DATE OF PLANTING, MARCH 16, 1910.

Pot No.	1910							1911		Total
	3-30	4-14	5-4	6-2	10-1	10-26	11-20	3-9	9-21	
1. Check soil from old wheat land	5	0	0	2	1	0	0	8*	0	16
2. Check same soil as ½ sand	8	2	3	2	0	0	0	0	1	16
3 Check pure sand	6	2	2	0	0	0	0	3*	0	13
4. Check pure subsoil and clay 29 feet down	0	0	0	0	0	0	0	0	0	0
5. Wheat soil made alkaline by use of 500 cc 10% solution of NH_3 & $NaCO_3$ 4 grams in 1 liter of water	2	0	0	0	0	0	0	0	0	2
6. Wheat soil ½ sand; treated as in 5	0	2	0	2	1	0	0	0	0	5
7. Pure sand treated as in 5	0	0	0	0	0	0	0	0	0	0
8. Clay subsoil treated as in 5	1	1	2	0	0	0	0	0	1	5
9. Wheat soil made acid by adding 500cc of a 5% solution of H_2SO_4 and 1 liter of water containing 4 grams of oxalic acid	0	0	0	0	0	0	0	0	0	0

10. Wheat soil and ½ sand made acid as in 9	2	1	1	0	0	0	0	0	0	4
11. Pure sand made acid as in 9	3	1	2	1	0	0	0	0	0	7
12. Subsoil and clay made acid as in 9	1	1	2	0	0	0	0	0	0	4
13. Wheat soil and ¼ wood ashes	2	0	0	0	0	0	0	0	0	2
14. Wheat soil, ½ sand ½ wood ashes to which ¼ volume of wood ashes was added	3	1	0	0	0	0	0	0	0	4
15. Pure sand mixed with ¼ volume wood ashes	6	1	1	0	1	0	0	0	0	9
16. Subsoil mixed with ¼ volume wood ashes	0	1	0	0	0	0	0	0	0	1
17. Wheat soil mixed with ¼ volume air slacked lime	0	1	1	0	0	0	0	7*	0	9
18. Wheat soil and sand mixed with ¼ volume air slacked lime	0	0	0	0	0	0	0	0	0	0
19. Pure sand mixed with ¼ volume air slacked lime	0	3	0	0	0	0	0	0	0	3
20. Subsoil mixed with ¼ volume air slacked lime	0	2	2	1	0	0	0	3*	0	8
21. Wheat soil moistened with 1 liter of water containing 20 grams of NaCl	2	0	0	0	0	0	0	3*	0	5
22. Wheat soil ½ sand ½ treated as in 21	3	3	1	0	0	0	0	0	0	7
23. Pure sand treated as in 21	7	5	0	0	0	0	0	0	0	12
24. Subsoil treated as in 21	7	2	2	0	0	0	0	0	0	11
25. Wheat soil mixed with ¼ well composted manure	1	0	0	0	0	0	0	2	0	3
26. Wheat soil ½ sand ½ mixed with ¼ volume composted manure	1	2	0	2	1	0	0	0	0	6
27. Sand mixed with ¼ volume compost	3	1	2	0	0	0	0	0	0	6
28. Pure subsoil mixed with ¼ volume compost	2	1	2	0	0	0	0	0	0	5
29. Wheat soil moistened with 20cc of saturated solution of crude nitrate cake	1	0	0	0	0	0	0	0	0	1
30. Wheat soil ½, sand ½, treated as in 29	1	6	0	0	0	0	0	0	0	7
31. Pure sand treated as in 29	3	1	0	0	0	0	0	0	0	4
32. Pure subsoil treated as in 29	0	0	0	0	0	0	0	0	0	0

*Those marked with an asterisk were saturated with water and placed out of doors so that they were solidly frozen up for 5 days during March, 1911, when these were brought back into the greenhouse germinations occurred as indicated, but no further germinations followed.

Considering this table of results it is interesting to observe that there was a very low percentage of germination from these actual hard seeds. The highest per cent germinated in 18 months under these variable conditions were 16 seeds. These germinations as shown by the table are scattered irregularly over the period, most of them occurring in the first few days. The highest germination took place in the light soils, sand mixtures, etc. The lowest occurred in clay subsoil. This would appear to indicate that soil conditions have something to do with the freedom with which these hard seeds germinate. There is nothing to indicate that the chemical conditions of the soil had anything to do with it. The best aerated soils give the best results and the ones solidly frozen showed some improvement.

On December 25 1911, an attempt was made to recover some of the hard seeds. The seeds were washed out of the dirt and examined, and in all cases found to be essentially as perfect and as bright as on the day placed in the pot. These were dried, placed in a standard germinator and the sprouts counted on the 5th day. The following table shows the number of the pot, the number of seeds recovered and the number of seeds which sprouted in the standard germinator when given an opportunity.

Pot Number	Number Seeds Recovered	Number Germinated on 5th Day
1	16	2
8	2	1
11	18	1
12	3	1
17	11	1
19	1	0
20	1	0
24	3	0
25	29	1
27	1	0
30	1	1
32	3	0

These experiments and others indicate clearly that if hard seeds of clover and alfalfa are to be of value to farmers they must be treated in some manner to make them more via-

ble. In Germany such seeds are sometimes ground in a machine, so that the seed coats are polished or scratched in a sort of centrifugal machine, causing them to be thinner so that water will be taken up. A number of experiments by scratching convinces us that this is all that is necessary, and the use of such machines by our seed houses upon their alfalfa and clover seed which show a high percentage of hard seed would probably prove of advantage not only to the seedsmen, but the purchasers of such seed. We have, however, worked on the theory that it may be possible to perfect a treatment. The following table of preliminary trials will furnish some interesting data as to the possibility of perfecting some form of solution treatment. All germinations in this table were set so as to have check contrasts and the period of germination for the treatment was the same as that for the check. In experiments Nos. 102 to 520 the period of incubation was 5 days. For all numbers above 520 the period of incubation was 6 days. These treatments can eliminate the hard seed, but as they approach sufficient severity to do this the dead seed is often greatly increased. The results obtained would indicate the possibility of effective treatment by live steam, hot water, caustic potash or caustic soda, or by sulphuric acid. The range, however, is narrow, and persons working along this line will need to carefully experiment before making application in any large way. The writer would especially call attention to the results obtained in the following numbers: Experiment Nos. 103, 117, 142, 144, 145, 148, 149, 162, 169, 173, 183, 504, 509 and 532. Date of experiment, November 9, 1908 to April 6, 1909.

MEDIUM RED CLOVER GROWN AT HILLSBORO, N. D., (Sarles' Sample.)

(In this table the hard and the dead seeds for experiments No. 104 to 184 inclusive, were counted together.)

Ex. No.	Treatment	Germinated	Hard	Dead
102	Check	78%	20	2%
103	Heavily scratched	98%	0	2%
104	Boiling water 5 minutes	4%	0	96%
105	Boiling water 1 minute	76%	0	24%

Ex. No.	Treatment	Germinated	Hard	Dead
106	Boiling water 3 minutes	56%	0	44%
107	Cold water 3 hrs.			
	Boiling water 1 minute	31%	0	69%
108	Cold water 3 hrs.			
	Boiling water 3 minutes	12%	0	88%
109	Cold water 3 hrs.			
	Boiling water 5 minutes	4%	0	96%
110	Cold water 5 hrs.			
	Boiling water 1 minute	75%	0	25%
111	Cold water 5 hrs.			
	Boiling water 3 minutes	31%	0	69%
112	Cold water 5 hrs.			
	Boiling water 5 minutes	8%	0	92%
113	12 hrs. in seed pan, warm room (Chk)	76%	0	24%
	12 hours outside, 19° above zero			
	12 hours warm room			
	12 hours outside			
	Alowed to germinate in warm room	76%	0	24%
114	Same as No. 113	76%	0	24%
116	1% NoOH 1 minute	73%	0	27%
117	1% NaOH 5 minutes	86%	0	14%
118	1% NaOH 7 minutes	65%	0	35%
119	1% NaOH 10 minutes	65%	0	35%
120½	1% K O H 1 minute	67%	0	33%
121	1% K O H 5 minutes	65%	0	35%
122	1% K O H 7 minutes	68%	0	32%
123	1% K O H 10 minutes	67%	0	33%
124	Boiling water 1 minute			
	Dried. 11° Fahr.	65%	0	35%
125	Boiling water 3 minutes			
	Dried. 115° Fahr.	36%	0	64%
126	Boiling water 5 minutes			
	Dried. 115° Fahr.	25%	0	75%
127	Boiling water 10 minutes			
	Dried. 115° Fahr.	54%	0	46%
134	Warm. NaOH .1% 1 minute	76%	0	29%
135	Warm. NaOH .1% 5 minutes	80%	0	20%
136	Warm. NaOH .1% 7 minutes	82%	0	18%
137	Warm. NaOH .1% 10 minutes	85%	0	15%
138	Warm. K O H .1% 1 minute	77%	0	23%
139	Warm. K O H .1% 5 minutes	79%	0	21%
140	Warm. K O H .1% 7 minutes	77%	0	23%
141	Warm. K O H .1% 10 minutes	79%	0	21%
142	Warm. NaOH .1% 1 minute	90%	0	10%
143	Warm. NaOH .1% 10 minutes	50%	0	50%
144	Live steam 1 minute at 80°C	96%	0	5%
145	Live steam 5 minutes at 80°c	91%	0	9%
146	Live steam 7 minutes at 80°c	85%	0	15%
147	Live steam 10 minutes at 80°c	74%	0	26%
148	(Dried) 1 minute at 80°c	95%	0	5%
149	(Steamer 5 minutes at 80°c. Dried)	97%	0	3%
150	(Steamer 7 minutes at 80°c. Dried)	67%	0	33%
151	(Steamer 10 minutes at 80°c. Dried)	37%	0	63%
152	1% K O H 1 minute. Dried air	58%	0	42%
153	1% K O H 5 minutes. Dried	74%	0	26%

Ex. No.	Treatment	Germinated	Hard	Dead
154	1% warm K O H 7 minutes. Dried	28%	0	72%
155	1% warm K O H 10 minutes. Dried	44%	0	56%
156	1% NaOH 1 minute	70%	0	30%
157	1% NaOh 5 minutes	70%	0	30%
158	Check on above two	66%	0	34%
159	Boiling water 5 minutes	66%	0	34%
160	Boiling water 1 minute	80%	0	20%
161	1% NaOh 1 minute	84%	0	16%
162	1% NaOh 5 minutes	87%	0	13%
163	Check on above four	74%	0	26%
164	Boiling water 1 minute	82%	0	18%
165	Boiling water 5 minutes	84%	0	16%
167	1% warm NaOh. Dried 10 minutes	74%	0	26%
168	1% warm NaOh. Dried 20 minutes	50%	0	50%
169	Steam 1 minute. 80°c. Dried	94%	0	6%
170	Steam 5 minutes. 80°c. Dried	87%	0	13%
171	Steam 10 minutes. 80°c. Dried	63%	0	37%
172	Check	74%		20%
173	Steam 5 minutes. 40°c. Dried	90%	0	10%
174	Steam 10 minutes. 40°c. Dried	75%	0	25%
175	Steam 20 minutes. 40°c. Dried	74%	0	26%
176	Check on above	78%		
177	Steam 5 minutes. 40°c	81%	0	19%
178	Steam 10 minutes. 40°c	82%	0	18%
179	Steam 20 minutes. 40°c	73%	0	27%
180	Check on above three	79%	21	
181	Steam 1 minute. 90°c. Dried	37%	0	63%
182	Steam 5 minutes. 90°c. Dried	32%	0	68%
183	Steam 1 minute. 90°c. Dried	92%	0	8%
184	Steam 5 minutes. 90°c. Dried	76%	0	24%
459	.1 of 1% KOH Air dried	88%	11	1%
460	.1 of 1% KOH Air dried 30 minutes	85%	15	
461	.1 of 1% NaOh Air dried	84%	16	
462	.1 of 1% NaOh Air dried 30 minutes	83%	16	1%
463	.1 of 1% KNO_3 Air dried	87%	11	2%
464	.1 of 1% KNO_3 Air dried 30 minutes	83%	17	
465	30% Alc. Air dried	83%	14	3%
466	30% Alc. Air dried 30 minutes	83%	12	5%
467	1-200 formalin. Air dried	84%	12	4%
468	1-500 formalin. Air dried 30 minutes	70%	28	2%
469	Ether, then H_2O. Air dried	78%	21	1%
470	Ether, 30 minutes; H_2O 5 minutes Air dried	84%	15	1%
471	Gasoline Air dried	81%	16	3%
472	Gasoline Air dried 30 minutes	78%	21	1%
473	5% HCL Air dried	82%	12	2%
474	5% HCL Air dried 30 minutes	76%	16	8%
475	Kerosene Air dried	61%	23	6%
476	Kerosene Air dried 30 minutes	87%	10	3%
477	Cedar oil, Dried	81%	15	4%
478	Cedar oil, Dried 30 minutes	72%	24	4%
480	Check for 459 to 478	88%	10	2%
483	Kept damp with KOH .1 of 1% 5 hrs. Dried	78%	18	4%

Ex. No.	Treatment	Germinated	Hard	Dead
484	Kept damp with KNO_6 .1 of 1% 5 hrs. Dried	81%	16	3%
485	Kept damp with NaOH .1 of 1% 5 hrs. Dried	84%	13	3%
486	Kept damp with 30% Alc. 5 hrs. Dried	77%	21	2%
487	Kept damp with formalin 1-500 5 hrs. Dried	67%	16	17%
488	Kept damp in $HgCl_2$ 1-500 5 hrs. Dried	70%	12	18%
489	Over night in .1 of 1% KOH. Dried	67%	18	15%
490	Over night in .1 of 1% KNO. Dried	78%	15	7%
491	Over night in .1 of 1% NaOh. Dried	76%	13	11%
492	Over night in 30% Alc. Dried	74%	15	11%
493	Over night in formalin 1-500. Dried	64%	12	24%
494	Over night in $HgCl_2$ 1-500. Dried	38%	18	44%
500	.1 of 1% KOH 60°c	70%	12	8%
501	.1 of 1% KOH 60°c. Dried 6 minutes	81%	11	8%
502	.1 of 1% KOH 70°c. Dried 2 minutes	84%	7	9%
503	.1 of 1% KOH 70°c. Dried 4 minutes	79%	8	13%
504	.1 of 1% KOH 80°c. Dried 6 minutes	91%	6	3%
505	.1 of 1% KOH 80°c. Dried 3 minutes	79%	3	18%
506	Check on above six	84%	12	4%
507	.1 of 1% KNO_3 60°c. Dried 2 minutes	85%	7	8%
508	.1 of 1% KNO_3 60°c. Dried 6 minutes	65%	23	12%
509	.1 of 1% KNO_6 70°c. Dried 2 minutes	90%	6	4%
510	.1 of 1% KNO_3 70°c. Dried 4 minutes	88%	8	4%
511	.1 of 1% KNO_3 80°c. Dried 1 minute	89%	4	7%
512	.1 of 1% KNO_3 80°c. Dried 3 minutes	81%	7	12%
513	Check for Nos. 506 to 512	78%	20	2%
514	.1 of 1% NaOh 60°c. Dried 2 minutes	88%	8	4%
515	.1 of 1% NaOh 6°c. Dried 6 minutes	86%	8	5%
519	.1 of 1% NaOh 80°c. Dried 3 minutes	80%	4	16%
520	Check for Nos. 514 to 519	87%	11	2%
521	30% Alc. 60°c. Dried 2 minutes	89%	8	3%
522	30% Alc. 60°c. Dried 6 minutes	88%	10	19%
523	30% Alc. 70°c. Dried 2 minutes	81%	18	1%
524	30% Alc. 70°c. Dried 4 minutes	87%	7	6%
525	30% Alc. 80°c. Dried 1 minute	88%	9	3%
526	30% Alc. 80°c. Dried 3 minutes	89%	10	1%
527	Check on Nos. 521 to 527	89%	8	3%
528	$HgCl_2$ 1-500 60°c. Dried 2 minutes	....	....	....
529	$HgCl_2$ 1-500 60°c. Dried 6 minutes	82%	14	4%
530	$HgCl_2$ 1-500 70°c. Dried 2 minutes	85%	7	8%
531	$HgCl_2$ 1-500 70°c. Dried 4 minutes	85%	11	4%
532	$HgCl_2$ 1-500 80°c. Dried 1 minute	86%	7	7%
533	$HgCl_2$ 1-500 80°c. Dried 3 minutes	82%	3	12%
534	Check for Nos. 528 to 534	79%	17	4%
535	Kerosene 1 hour. Dried	79%	16	5%
536	Kerosene 2 hours. Dried	82%	11	7%
537	Kerosene 5 hours. Dried	88%	12	0%
538	Kerosene 8 hours. Dried	83%	13	3%
539	Kerosene 10 hours. Dried	81%	13	6%
540	Check for Nos. 535 to 540	84%	13	3%

In the following table a number of miscellaneous samples of clovers and alfalfa from different regions were tested.

RED CLOVER—OSCAR WILL, BISMARCK, NORTH DAKOTA.

Ex. No.	Treatment	Germinated	Hard	Dead
335	Water 5 minutes 60°c	85%	1	14%
336	Water 10 minutes 60°c	85%	0	15%
337	Water 20 minutes 60°c	91%	0	19%
338	Check on Nos. 335 to 337	88%	1	11%
339	Water 1 minute 70°c	93%	1	6%
340	Water 5 minutes 70°c	94%	1	5%
341		91%	3	6%
342	Check on No. 339 to 341	93%	2	5%
343	Water 1 minute 80°c	79%	3	18%
344	Water 2 minutes 80°c	78%	1	21%
345	Water 5 minutes 80°c	88%	0	12%
346	Check on Nos. 343 to 345	85%	1	14%
347	Water 1 minute 90°c	88%	0	12%
348	Water 2 minutes 90c	77%	0	23%
349	Water 5 minutes 90°c	15%	0	85%
350	Check on Nos. 347 to 349	94%	2	4%

RED CLOVER—CARTER & SHIM, LaMOURE.

Ex. No.	Treatment	Germinated	Hard	Dead
351	Water 1 minute 90°c	90%	0	10%
352	Water 2 minutes 90°c	77%	0	23%
353	Water 5 minutes 90°c	21%	0	79%
354	Check on Nos. 351 to 353	94%	0	6%
355	Water 1 minute 80°c	94%	0	6%
356	Water 2 minutes 80°c	88%	0	12%
357	Water 5 minutes 80°c			
358	Check on Nos. 355 to 357	79%	0	21%
359	Water 2 minutes 70°c	88%	0	12%
360	Water 5 minutes 70°c	90%	3	7%
361	Water 10 minutes 70°c			
362	Check on Nos. 359 to 361	92%	0	8%
363	Water 5 minutes 60°c	84%	0	16%
364	Water 10 minutes 60°c	93%	0	7%
365	Water 10 minutes 60°c	72%	0	26%
366	Check on Nos. 363 to 365	93	0	7%

RED CLOVER—WM. PAGE, HAMILTON.

Ex. No.	Treatment	Germinated	Hard	Dead
367	1% NaOH 1 minute 90°c	94%	4	2%
368	1% NaOH 2 minutes 90°c	88%	1	11%
369	1% NaOH 5 minutes 90°c	5%	0	95%
370	Check on Nos. 367 to 369	82%	16	2%
371	1% NaOH 1 minute 80°c	90%	7	3%
372	1% NaOH 2 minutes 80°c	89%	9	2%
373	1% NaOH 5 minutes 80%	32%	0	68%
374	Check on Nos. 371 to 373	78%	21	1%
375	1% NaOH 2 minutes 70°c	88%	10	2%
376	1% NaOH 5 minutes 70°c	85%	14	1%

Ex. No.	Treatment	Germinated	Hard	Dead
377	1% NaOH 7 minutes 70°c	69%	4	29%
378	Check on Nos. 375 to 377	75%	24	1%
379	1% NaOH 5 minutes 60°c	89%	9	2%
380	1% NaOH 7 minutes 60°c	95%	3	2%
381	10% NaOH dip	84%	10	6%
382	Check on Nos. 379 to 381	85%	13	2%
441	Water 1 minute 80°c	88%	2	10%
442	Water 2 minutes 80°c	84%	4	12%
443	Water 4 minutes 80°c	78%	3	19%
444	Check on Nos. 441 to 443	72%	21	7%

McCABE BROS., GLASSTON.

285	H_2O 80°c 5 minutes	57%	3	40%
286	H_2O 80° 5 minutes	87%	12	1%
287	H_2O 80° 5 minutes	79%	2	19%
288	Check on Nos. 285 to 287	80%	9	11%

G. B. MURRAY, CANDO.

290 a	H_2O 80°c 5 minutes	69%	6	25%
290 b	Check on No. 290 (a)	68%	13	19%
291 a	H_2O 80°c 5 minutes	72%	3	25%
291 b	Check on No. 291 (a)	67%	19	14%
292 a	H_2O 80° 5 minutes	56%	3	41%
292 b	Check on No. 292 (a)	91%	7	2%

DAN S. LEWIS, FARGO.

219	Steam 80°c 5 minutes	71%	1	28%
220	Check on No. 219	79%	5	16%

OSCAR WILL, BISMARCK.

221	Steam 80°c 5 minutes	76%	2	22%
222	Check on No. 221	93%	5	2%

A DICKINSON CO., MINNEAPOLIS

223	Steam 80°c 5 minutes	75%	1	24%
224	Check on No. 223	89%	8	3%

WHITE CLOVER—A DICKINSON CO., MINNEAPOLIS.

Ex. No.	Treatment	Germinated	Hard	Dead
225	Steam 80°c 5 minutes	60%	2	38%
226	Check on No. 225	84%	2	14%

RED CLOVER—C. B. McMILLAN, HANNAH.

227	Steam 80°c 5 minutes	71%	1	28%
228	Check on No. 227	85%	12	3%

J. R. McCONNEHEY, FARGO.

237	Steam 80°c 5 minutes	81%	0	19%
238	Check on No. 237	87%	8	5%

O. J. BARNES, GRAND FORKS.

Ex. No.	Treatment	Germinated	Hard	Dead
239	Steam 80°c	85%	2	13%
240	Check on 239	89%	8	3%
241	Steam 80°c 5 minutes	91%	4	5%
242	Check on No. 241	79%	18	3%

MAGILL & CO., FARGO.

243	Steam 80°c 5 minutes	66%	3	31%
244	Check on No. 243	70%	7	23%

BANK OF WEBSTER, WEBSTER.

297	Steam 80°c 1 minute	55%	5	40%
298	Check on No. 297	90%	7	3%
318	Water 1 minute 90°c	92%	1	7%
319	Water 2 minutes 90°c	45%	0	55%
320	Water 5 minutes 90°c	19%	0	81%
321	Check for Nos. 318 to 320	95%	2	3%
322	Water 1 minute 80°c	97%	1	2%
323	Water 2 minutes 80°c	76%	0	24%
324	Water 5 minutes 80°c	51%	0	49%
325	Check on Nos. 322 to 324	93%	2	5%
326	Water 1 minute 70°c	95%	2	3%
327	Water 5 minutes 70°c	66%	1	33%
328	Water 10 minutes 70°c	69%	1	30%
329	Check on Nos. 326 to 328	93%	2	5%
330	Water 5 minutes 60°c	84%	1	15%
331	Water 10 minutes 60°c	63%	1	36%
332	Water 20 minutes 60°c	63%	0	37%
333	Check on Nos. 330 to 333	94%	3	3%

ALFALFA—BLACKMAN & GRIFFIN, OGDEN, UTAH.

293	Water 80°c 1 minute	68%	2	30%
294	Water 80° 2 minutes	65%	5	30%
295	Water 80°c 5 minutes	42%	6	52%
296	Check on Nos. 293 to 295	41%	43	16%
302	Water 1 minute 90°c	78%	8	14%
303	Water 2 minutes 90°c	78%	3	19%
304	Water 5 minutes 90°c	52%	3	45%
305	Check on Nos. 302 to 304	51%	37	12%
306	Water 1 minute 80°c	78%	2	20%
307	Water 2 miutes 80°c	81%	1	18%
308	Water 5 minutes 80°c	71%	7	22%
309	Check on Nos. 306 to 308	52%	40	8%
310	Water 1 minute 70°c	70%	23	7%
311	Water 5 minutes 70°c	68%	24	8%
312	Water 10 minutes 70°c	59%	4	27%
313	Check on Nos. 310 to 312	53%	36	11%
314	Water 5 minutes 60°c	63%	23	14%
315	Water 10 minutes 60°c	64%	27	9%
316	Water 20 minutes 60°c	58%	12	29%
317	Check on Nos. 314 to 316	52%	39	9%

ALFALFA—FRANK P. ROOT, LAKOTA, N. D.

Ex. No.	Treatment	Germinated	Hard	Dead
245	H_2O 1 minute 90°c	91%	2	7%
246	H_2O 2 minutes 90°c	89%	2	9%
247	H_2O 5 minutes 90°c	30%	0	70%
248	Check on Nos. 245 to 247	84%	14	2%
249	H_2O 1 minute 80°c	98%	1	1%
250	H_2O 2 minutes 80°c	91%	6	3%
251	H_2O 5 minutes 80°c	74%	0	26%
252	Check on Nos. 249 to 251	83%	14	3%
253	H_2O 1 minute 70°c	93%	5	2%
254	H_2O 5 minutes 70°c	92%	5	3%
255	H_2O 10 minutes 70°c	91%	3	6%
256	Check on Nos. 253 to 255	88%	9	3%
257	H_2O 60°c 5 minutes	85%	8	7%
258	H_2O 60°c 10 minutes	92%	5	3%
259	H_2O 60°c 20 minutes	83%	15	2%
260	Check on Nos. 257 to 259	85%	13	2%
261	H_2O 50°c 5 minutes	85%	14	1%
262	H_2O 50°c 15 minutes	89%	5	6%
263	H_2O 50°c 30 minutes	82%	10	8%
264	Check on Nos. 261 to 263	84%	13	4%
265	H_2O 90°c 1 minute	81%	1	18%
266	H_2O 90°c 2 minutes	89%	0	11%
267	H_2O 90°c 5 minutes	52%	0	48%
268	Check on Nos. 265 to 268	83%	7	10%
269	H_2O 80°c 1 minute	95%	4	1%
270	H_2O 80°c 2 minutes	95%	4	1%
271	H_2O 80°c 5 minutes	93%	7	0%
272	Check on Nos. 269 to 271	73%	27	4%
273	H_2O 70°c 1 minute	89%	11	0%
274	H_2O 70°c 5 minutes	91%	7	2%
275	H_2O 70°c 10 minutes	84%	5	11%
276	Check on Nos. 273 to 275	74%	24	2%
277	H_2O 60°c 5 minutes	85%	13	2%
278	H_2O 60°c 10 minutes	84%	12	4%
279	H_2O 60°c 20 minutes	87%	9	4%
280	Check on Nos. 277 to 279	72%	24	4%
281	H_2O 50°c 5 minutes	72%	28	0%
282	H_2O 50°c 15 minutes	83%	14	3%
283	H_2O 50°c 30 minutes	77%	18	5%
284	Check on Nos. 281 to 283	84%	13	3%

ALFALFA—OSCAR WILL, BISMARCK.

195	Steam 80°c 5 minutes	43%	0	57%
196	Check	44%	0	56%

FRANK P. ROOT, LAKOTA.

194	Steam 80°c 5 minutes	91%	0	9%
193	Check	99%	0	

ALFALFA—L. J. SCHUPPERT, MICHIGAN, N. DAK.

197	Steam 80°c 5 minutes	89%	0	11%
198	Check	91%	0	9%

H. WHIPPLE, DEVILS LAKE.

199	Steam 80°c	96%	0	4%
200	Check	96%	0	4%

ADOLPH REIMERS, BASTO.

299	Steam 80°c 5 minutes	55%	1	44%
230	Check	82%	8	10%

RED CLOVER —CLARK KELLY, DEVILS LAKE.

231	Steam 80°c 5 minutes	81%	2	7%
232	Check	97%	2	1%

E. Y. SARLES, HILLSBORO.

233	Steam 80°c 5 minutes	35%	1	64%
234	Check	46%	18	36%

ALFALFA—A. DICKINSON & CO., MINNEAPOLIS

235	Steam 80°c	93%	2	5%
236	Check	85%	14	1%

ALSIKE—A. DICKINSON & CO.

209	Steam 80°c 5 minutes	92%	2	6%
210	Check	93%	5	2%

MONTANA ALFALFA—OSCAR WILL, BISMARCK.

211	Steam 80°c 5 minutes	80%	0	20%
212	Check	85%	8	6%

ALFALFA—G. W. FOOGMAN, GRAFTON.

213	Steam 80°c 5 minutes	48%	0	52%
214	Check	39%	10	51%

RED CLOVER—O. J. BARNES, GRAND FORKS.

217	Steam 80°c 5 minutes	90%	1	9%
218	Check	78%	17	5%

CRIMSON CLOVER, LaMOURE.

404	1 minute H_2O 90°c	0	0	100%
405	2 minutes H_2O 90°c	1%	0	99%
406	5 minutes H_2O 90°c	0	0	100%
407	Check on Nos. 404 to 406	94%	0	6%
408	1 minute H_2O 80°c	5%	0	95%
409	2 minutes H_2O 80°c	10%	0	90%
410	5 minutes H_2O 80°c	0	0	100%
411	Check on Nos. 408 to 410	92%	0	8%
412	2 minutes H_2O 70°c	56%	0	44%
413	3 minutes H_2O 70°c	55%	0	45%
414	6 minutes H_2O 70°c	3%	0	97%
415	Check on Nos. 412 to 414	94%	0	6%

Treatment with Sulphuric Acid:—Aside from these an extended list of treatments were carried on with sulphuric acid. The following table shows the possibility of improving such hard seeds by means of dipping the seed in sulphuric acid.

Kind of Seed and Record No. of Sample	Test of Untreated Seed			Test After Acid Treatment		
	Percent Germinated	Percent Hard	Percent Dead	Percent Germinated	Percent Hard	Percent Dead
Alfalfa No. 355	51	46	3	83	8	9
Alfalfa No. 421	97	--	3	99	--	1
Red Clover No. 379	61	32	7	83	10	7
Red Clover No. 376	86	6	8	96	--	4

It is evident from a consideration of the foregoing treatments of hard seeds that there is going to be quite a considerable range in the possible treatments of these hard seeds. It is also evident that until extended field tests are carried out in the testing work that it would not be wise for any farmer to undertake the treatment of any large volume of seeds. I believe that the tables as given are of sufficient range to aid anyone to shape a treatment which may become effectual in the hands of any person who is able to make a reliable germination test of alfalfa seed. It is my opinion that such treatments will, however, only be of use to those who are immediately ready to sow the seed.

Grimm Alfalfa Seed:—Possibilities of Distinguishing it From Ordinary Alfalfa Seed:—It is very difficult to tell Grimm alfalfa seed from ordinary alfalfa seed, though it may yet be possible to learn some distinctive characters by which this may be done. In the following table an attempt was made to ascertain whether it was possible to distinguish the Grimm alfalfa seed from ordinary alfalfa seed by means of speeal methods of treating the seed. The following studies, conducted by Mr. J. R. Campbell to determine whether Grimm alfalfa seed can be distinguished from ordinary alfalfa because of its greater resistance to cold may prove an interesting record for the carrying out of further experiments along similar lines:

"In the following study, 19 samples of alfalfa seed from various sources were used. Six of these were Grimm seed

from A. B. Lyman. All were germinated in six lots as follows:

Lot 1 Check lot. Germinated in ordinary manner.

Lot 2 Exposed over night to temperature of 19°C., then planted.

Lot 3 Placed in water and frozen over night at same time and temperature as Lot 2.

Lot 4 Soaked in water over night, then placed in freezing chamber and exposed to temperature of 10°C for one hour, then thawed gradually before planting

Lot 8 Soaked in water 18 hours, then dried for two hours before planting.

Lot 11 Soaked six hours, then frozen over night at temperature of 9°C. thawed rapidly and planted.

All samples were planted in triplicate and the figures in the following table represents the averages of the three.

The resulting figures seem to show that the tests were not rigorous enough to affect the viability of any of the samples.

Record No. and Source	Lot 1		Lot 2		Lot 3		Lot 4		Lot 8		Lot 11	
	Viable seed	Hard seed	Viable seed	Hard seed	Viable seed	Hard seed	Viable seed	Hard seed	Viable seed	Hard seed	Viable seed	Hard seed
Kansas:												
5657	57	41	61	36	52	44	54	43	45	45	54	42
5658	82	12	80	11	81	11	87	13	77	10	77	13
5659	93	3	95	5	93	5	87	6	90	5	91	7
5660	91	8	90	8	87	9	88	11	80	9	92	7
Montana:												
5707	89	7	94	5	85	6	88	8	90	7	89	9
5718	85	9	90	7	85	8	84	9	86	9	88	10
5719	88	10	91	8	85	8	86	10	88	11	85	10
6004	88	8	84	13	88	8	84	11	85	10	78	10
N. Dakota:												
5748	75	23	79	18	77	20	66	25	63	28	70	30
5807	55	41	58	39	51	38	80	18	54	43	59	38
5808	69	25	69	25	73	18	70	25	68	22	68	26
5840	62	36	55	44	63	35	57	41	60	33	61	35
5888	65	33	63	36	64	34	65	35	62	37	63	38
GRIMM SAMPLES FROM A. B. LYMAN, EXCELSIOR, MINN.												
Montana:												
5560	68	31	72	27	69	30	65	32	73	23	71	27
Nebraska:												
5569	82	11	75	14	83	13	84	12	86	8	81	10
Montana:												
5885	82	17	88	11	85	10	85	11	85	14	83	17
Minnesota:												
5889	56	43	55	43	57	38	60	33	56	44	55	44
5891	49	51	45	54	38	60	50	49	48	51	39	49
5893	63	35	63	35	69	35	61	35	57	37	57	38

Tentative Experiments:—As is our usual policy we have kept up a number of tentative experiments on lines of allied work.

Cooperative Experiments With Wheat:—The department having worked upon a number of strains of wheat with a view of gaining resistance to rust and other diseases found itself able to furnish some samples of seed which might help to determine whether there is any possibility of procuring wheats of more resistant type. Five or six strains of such seed were distributed to approximately 50 farmers with a view of testing under different weather and soil conditions. These are grown not with a view of increasing the seed for distribution, but with a view of determining in an experimental way whether any resistance to disease has been gained through our method of work with wheat as in the case with flax.

Cooperative Tests With Small Seeded Russian Sunflowers for Oil Production:—Many requests have come to this department, especially from manufacturers interested in the manufacture of oils, to ascertain whether the Russian small seeded sunflower will thrive in this region or not. Sunflower seeds were procured by cooperation with the Bureau of Seed Introduction of the Department of Agriculture at Washington, D. C., and ten farmers agreed to make cooperative test of the seed. No farmer failed to get the seed to mature and the yields produced under the dry weather conditions were very encouraging. It is possible that the Russian sunflower might make a good cultivated crop for North Dakota conditions, provided the seed is found of sufficient commercial value.

Wheat Trenching Experiments:—A small experiment was put on to determine the value of a trenching system with reference to wheat. Farmers have complained that wheat does not properly stool in this region. The author thought that some trenching system might prove beneficial. A trench was prepared approximately 10 inches deep and wheat of various varieties were planted in the bottom of this trench. Arrangements were made so that there would be good surface drainage, at least as deep as the bottom of this

trench. The wheat was planted 2 inches deep and as it came up the dirt was pulled in over it as follows:

May 31—1 inch.

June 8—1½ inches.

June 22—2 inches.

July 1—2 inches.

July 10—1½ inches.

The drouthy season was apparently particularly favorable to this sort of an experiment. As an actual fact the experiment failed. Our observations convinced us that there would have been abundant stooling had it not been for the various wheat pests associated with the seed. Under this system of planting they became very destructive, and tho the wheat attempted to stool early, because of the continual addition of dirt about it the stools died faster from root diseases than they could form. In the presence of root diseases the trenching system it seems will be certain to be doomed to failure. For such work clean soil and clean seed will be a necessity. During the coming year we hope to try the trenching system on virgin soil with as near disease free seed as possible.

Correspondence and Publication: The demand upon this department for its publications and by way of direct correspondence work has greatly increased during the past year, and every effort is being made to furnish the practical results of our experiments to the farmer in such way that they be made use of and tested out by the farming public.

Respectfully submitted,

H. L. BOLLEY,

Botanist and Plant Pathologist and State Seed Commissioner.

HORTICULTURAL DEPARTMENT

To Director J. H. Worst,

Sir: The work of the Department of Horticulture and Forestry for the year 1911 included field trials and selections of all the standard garden crops, a considerable addition to the fruit plantations and a continuation of the work on the principal forest trees, particularly with relation to withstanding drouth.

Insect ravages also were given considerable attention and field trials and observations looking toward the extermination of the more serious insect pests were carried on during the season. The work was confined chiefly to blister beetles, wire-worms, cutworms, grasshoppers, and a small noctuid that was generally spoken of as the army worm but differing from the common northern army worm.

The work with vegetables also included the growing of celery, tomatoes, and cabbage on a commercial scale to determine their value as commercial crops and the most profitable methods of growing and marketing for local conditions. In this connection a small canning plant was established and over 2500 gallons of tomatoes canned for market.

Pipes for irrigation were extended to the gardens for the purpose of carrying on irrigation work with garden crops and small fruits.

The Department is greatly in need of storage cellars to develop the commercial features of gardening and also of plant houses for work in the improvement of fruits which cannot be profitably undertaken with the present equipment. Steps are being taken to secure an assistant to take the place of Mr. McMeans who resigned in November.

Respectfully submitted,

C. B. WALDRON.

President J. H. Worst Director,

Government Experiment Station,

Agricultural College, N. Dak.

Sir:—In compliance with your request of the 1st inst., I beg to report that during the year ending January 31st, 1912, your department of veterinary science has continued its research work on swamp fever in horses.

As the results of the greater part of those investigations were made public in the North Dakota Station Bulletin No. 94, we respectfully refer to this publication for the details of the work.

The research is being continued, with a special view of finding a reliable means of diagnosis applicable to the so-called non-clinical field cases. This work is as yet of a preliminary nature but will be pushed to a conclusion during the ensuing year.

Yours respectfully,

L. VAN ES.

STATEMENT

United States Appropriations, 1910-1911.

Receipts	Hatch Fund	Adams Fund
To receipts from the Treasurer of the United States as per appropriation for fiscal year ending June 30th, 1911, under acts of Congress approved March 2nd, 1887, (Hatch Fund) and March 16th, 1906, (Adams Fund)	$15,000.00	$15,000.00
Disbursements.		
Salaries	$ 9,860.52	$10,139.62
Labor	3,617.67	1,541.67
Publications	620.49	
Postage and Stationery	42.11	48.36
Freight and Express		13.40
Heat, Light and Water		
Chemical Supplies	1.80	231.62
Seeds Plants and Sundry Supplies	166.81	182.31
Fertilizers		
Feeding Stuffs		466.53
Library		88.05
Tools Implements and Machinery	7.00	125.30
Furniture and Fixtures	170.00	127.25
Scientific Apparatus	292.66	652.68
Live Stock		659.50
Traveling Expenses	19.30	47.70
Contingent Expenses	25.00	30.00
Building and Repairs	176.64	646.01
Total	$15,000.00	$15,000.00

Job 6576 Date

Mend by Time

Stab by No. Sect. Sew by

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